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Vol. 21 July–August, 1921 No. 4

TORREYA

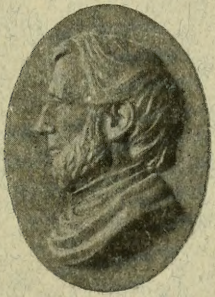
A BI-MONTHLY JOURNAL OF BOTANICAL NOTES AND NEWS

EDITED FOR

THE TORREY BOTANICAL CLUB

BY

GEORGE T. HASTINGS



JOHN TORREY, 1796–1873.

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TORREYA

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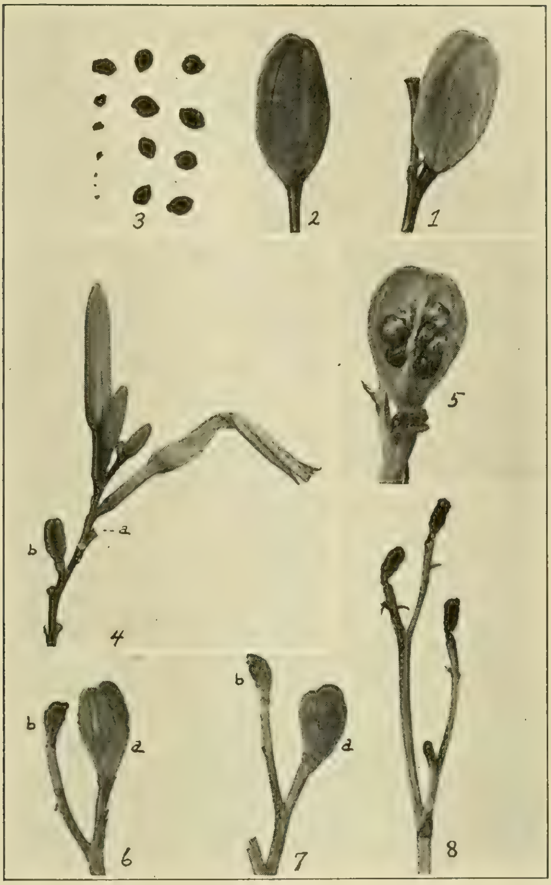

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A. B. Stout.

New York Botanical Garden.

AN ORTHOTROPOUS OVULE IN *HYACINTHUS ORIENTALIS* L.

While sectioning ovaries of the hyacinth for embryo sacs one ovary was found which shows two irregularities. One of the ovules in the upper part of the ovary is orthotropous instead of anatropous. This ovule, as figure 1 shows, is typical in all other respects, the integuments, micropyle, nucellus, and embryo sac being well formed and apparently functional. In the median portion of the ovary the carpels seem to be incompletely fused and the placentas are slightly displaced (Fig. 2). Mas-

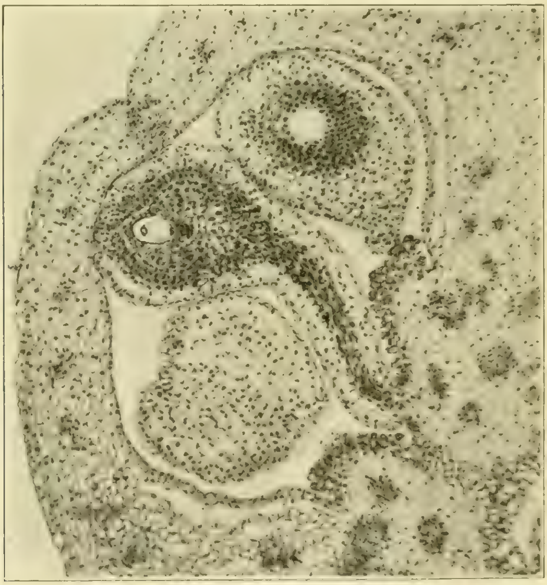

Fig. 1

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(3) **The Preliminary Catalogue of Anthophyta and Pteridophyta** reported as growing within one hundred miles of New York, 1888. Price, $1.00.

Correspondence relating to the above publications should be addressed to

DR. F. J. SEAVER
New York Botanical Garden
Bronx Park, New York City

CONTRIBUTIONS FROM THE NEW YORK
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STERILITY AND FERTILITY IN HEMEROCALLIS

BY A. B. STOUT

NEW YORK
1921

Reprinted, without change of paging, from TORREYA, 21: 57-62. July-August, 1921

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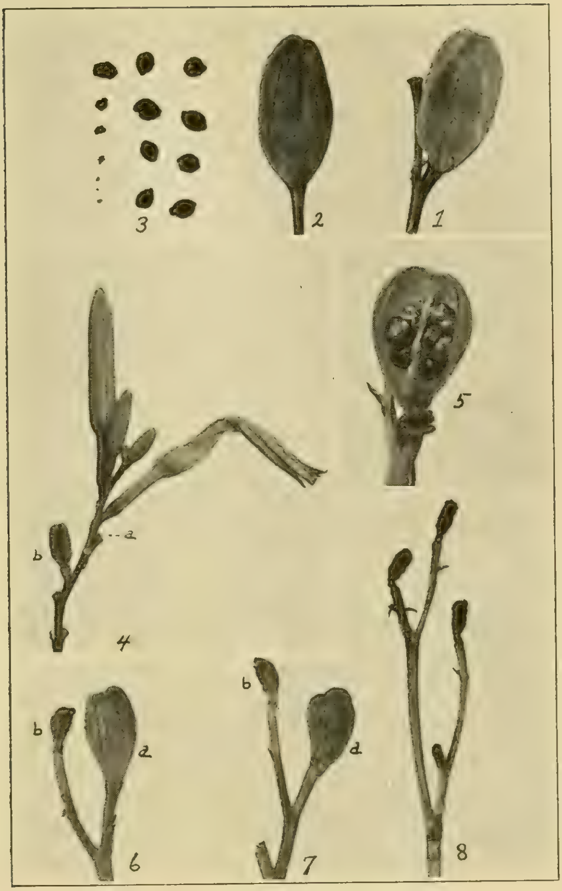

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JOURNAL

OF

THE NEW YORK BOTANICAL GARDEN

NEW DAY LILIES
A. B. STOUT

SEEDS: THEIR TRICKS AND TRAITS
WILLIAM CROCKER

A FREAK OF THE MOUNTAIN LAUREL
ELIZABETH G. BRITTON

NOTES, NEWS, AND COMMENT

ACCESSIONS

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JOURNAL

OF

The New York Botanical Garden

Vol. XXVI August, 1925 No. 308

NEW DAY LILIES

Numerous new varieties of day lilies (*Hemerocallis*) have recently been developed at The New York Botanical Garden through hybridization. These plants extend considerably the range in the color, size, and shape of the flowers for this group of ornamentals and include a goodly number of hybrids whose flowers are pleasing and attractive. The results already realized indicate that the rather simple flower colors of the older species may be broken up, recombined, and even intensified through hybridization, thus producing an increased diversity and yielding new forms of special interest and value to the flower-grower.

The list of day lilies available for general garden culture and for breeding purposes is not a long one. There are, however, about ten recognized species in cultivation to begin with. Of these the lemon day lily (*Hemerocallis flava*) with its fragrant and clear yellow flowers and the still more common orange day lily (*H. fulva*) are best known. The record of their culture in Europe extends back nearly 500 years. Possibly they were brought to Europe from Asia as early as the time of Marco Polo. In recent years other species have been brought from the Old World to the New.

Of them all, *Hemerocallis fulva* has the gayest flowers. In this the throat of a flower is deep chrome, outside of which there is a zone of English red extending with decreasing intensity to the tip of the six flower segments. The pattern is fairly well indicated in Figure 2 (the middle flower of the upper row). The flower is bi-colored with the chrome and the red in conspicuous contrast.

For the flowers of the rather recently introduced species *H. aurantiaca* there is a rich orange throat, outside of which there is a delicate blending of orange and red with the red much more subdued and delicate than in the *H. fulva.*

For each of the other species the flower color is of an almost uniform shade of some grade of either yellow or orange.

It is to be stated that few persons have thus far contributed in any noteworthy extent to the horticultural improvement of the day lilies. Mr. George Yeld, of England, deserves special mention for the production of some dozen named hybrids involving the species *Hemerocallis flava, H. aurantiaca, H. Dumortierii, H. Thunbergii,* and *H. minor.* In Italy Mr. Carl Sprenger and his nephew, Mr. Willy Müller, obtained seed of *Hemerocallis* from China and grew seedlings which were related to but different from the old cultivated form of *fulva.* One of these, designated as *H. fulva* var. *maculata,* was successfully crossed with *H. citrina* by Müller but these seedlings were apparently lost during the recent war. Several of their hybrids between *H. aurantiaca* and *H. citrina,* obtained at an earlier date, were distributed to the trade in Europe. In a letter which the writer recently received from Mr. Müller it is stated that a head gardener at the Botanical Garden of the University in Strasbourg succeeded, about the year 1911, in obtaining a few hybrids by crossing the lemon day lily (*H. flava*) with pollen of *H. fulva.* This has been verified in a later letter received from Dr. Killian, of the Université de Strasbourg. It appears certain that the form of *fulva* involved in this cross is the one in common cultivation. If so, it is the first record of this cross having been accomplished during all the years that these two have been grown in Europe and America! It is possible to make this cross, for it has been done in the breeding work at The New York Botanical Garden and at present there is a total of 524 plants which have *H. fulva* as one parent or grandparent. The firm of Lemoine, well-known nurserymen and hybridizers in France, is credited with the production of two and possibly three hybrids, Luther Burbank is credited with two others, and several *H. citrina* hybrids have come from Mr. Bertrand H. Farr. Several other hybrids have appeared in the trade, mostly of origin unknown.

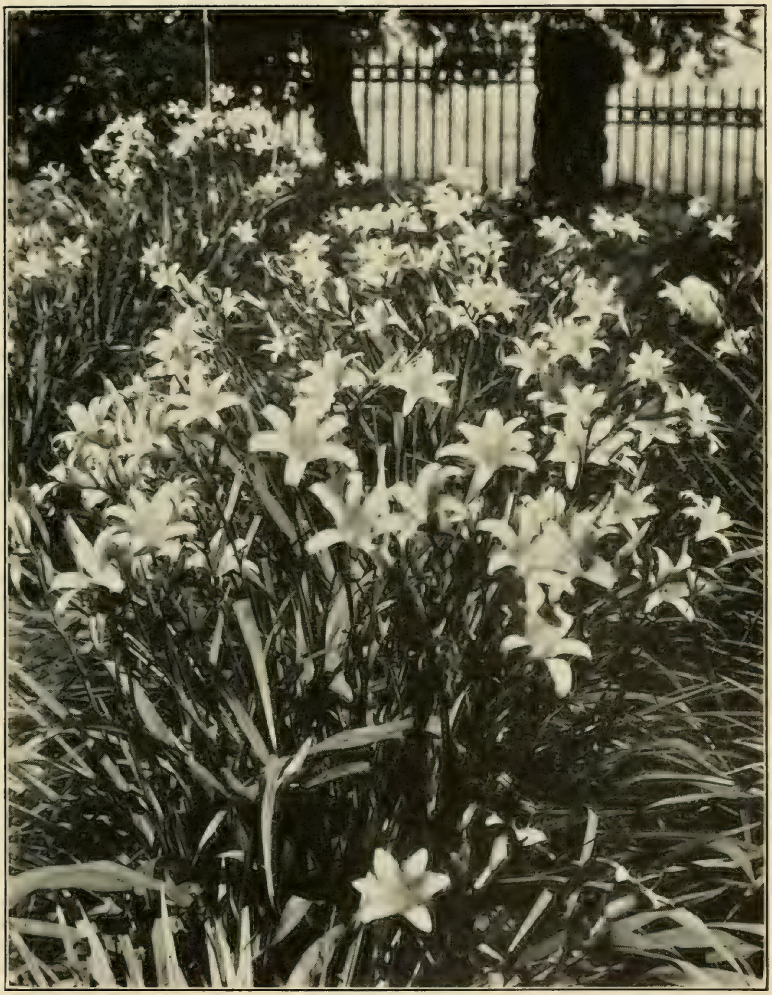

Figure 1. A glimpse of a few of the hybrid day lilies in the experimental plots at The New York Botanical Garden. The plants here shown are quite typical of many of the hybrids between the variety *luteola* and the species *H. aurantiaca*; they grow vigorously and give an abundance of bloom, which stands in the upper reaches of the foliage or slightly above. Most of the plants selected for propagation as new clonal varieties have this habit of growth, combined with flowers of attractive shapes and colors.

Thus a total of about 75, certainly not more than 100, hybrids in *Hemerocallis* have been reported to date. About 40 have been given varietal names but only about a dozen are to be had in the trade. The number available in the American trade is still less. When compared with such groups of plants as the dahlias, the roses, and the irises the flowers of the available day lilies taken collectively are lacking in diversity of color and form. Their improvement along these lines has been the chief aim of the breeding work undertaken at The New York Botanical Garden.

The first step in preparation for this breeding was to assemble all the known species and varieties obtainable. Persistent efforts have been made to secure the hybrids already produced as noted above but only 14 of these have been obtained at this date. Continued efforts are being made to obtain a more complete collection and also to obtain living plants growing wild in the interior of China in the hope that forms and perhaps species hitherto unknown to Europe and America may be had. Without doubt types of day lilies of interest and value to horticulture are yet to be discovered in Asia. During the past year plants have been obtained from China and from Japan which are different from any of the older species. These are being propagated and utilized in the breeding work.

The main task in the breeding work itself is to obtain seed and to grow seedlings particularly from crosses between different species and varieties but from self-pollination as well. When this is attempted it soon becomes evident why so few seedlings have previously been secured and why with the probable exception of the Strasbourg hybrids the " blood " of *H. fulva* has never been blended with any of the other species previous to the results reported in this paper.

The day lilies as a group possess a decided unfruitfulness or sterility. It is difficult and for some varieties even impossible to obtain seed to self-pollination. The majority of seedlings are fully self-incompatible. Crossing between species and varieties and even between seedlings of the same immediate parentage is greatly restricted. For example, the widely cultivated strain of the common orange day lily (*H. fulva*) has, it appears, never been known to yield fruit and seeds to any kind of pollination, self or cross, until four capsules (out of several thousand pollinations) were secured at The New York Botanical Garden. Neither has its pollen previously been used with success in any crosses unless this was done at Strasbourg.

And so the work of breeding day lilies resolved itself, first of all, into a study of the sterilities, or we may say, of the physiological incompatibilities (both self and cross) in the processes of fertilization. It has been a case of trying to circumvent or overcome the obstinate sterilities characteristic of these plants and most particularly of the gaily-colored *H. fulva.*

This work has been in progress for ten years. Thousands of controlled pollinations have been made. Crosses which did not succeed were repeated over and over until as in the *H. flava* and *H. fulva* cross a few seedlings were obtained. A cross that failed when made directly was sometimes made indirectly, so to speak, by using a third type as an intermediate parent. As a result the gayer and somewhat bold colors of the orange day lily have been both subdued and intensified in combination with shades of yellow, golden-yellow, and orange. This has also been done with the red tint of *Hemerocallis aurantiaca.* A color pattern rather closely resembling that of the commonly cultivated form of *H. fulva* has actually appeared in the flowers of certain hybrids between species other than *H. fulva.*

But certain crosses between species and varieties are easy to make. Thus the yellow-flowered *Hemerocallis flava* and the *H. Thunbergii* with lemon-yellow flowers readily hybridize with *H. aurantiaca.* The variety *luteola* (itself a hybrid between *H. aurantiaca* var. *major* and *H. Thunbergii*) readily hybridizes with *H. aurantiaca* and the seedlings of this cross are among the finest thus far obtained at The New York Botanical Garden. Of the combinations just mentioned more than two hundred hybrids have already bloomed. Hybrids between other species and varieties are also blooming. A total of about 1,500 hybrids (all different seedlings) are being grown.

The flowers of these hybrids taken collectively exhibit a wide range of colors from light lemon-yellow (even lighter than the old *Thunbergii*) to a very dark rich orange. Nearly all these shades are to be seen both in clear uniform color and in combination with various degrees of the red seen in *H. fulva* and *H. aurantiaca.* The red may be rather uniformly dispersed over the

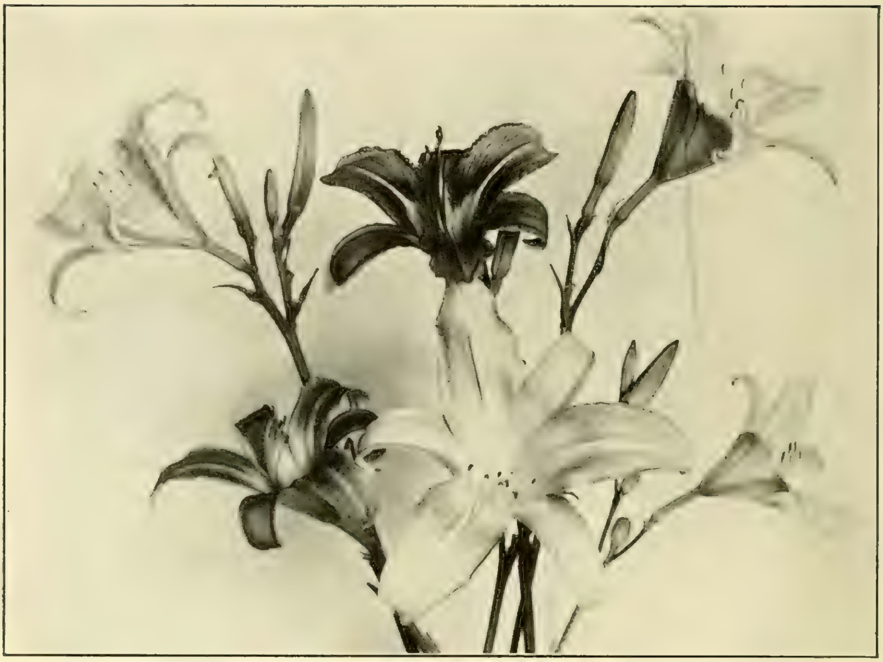

FIGURE 2. The conspicuously large flower in this group is from one of the finest of the new day lilies developed at The New York Botanical Garden. It has the largest full flower known for any *Hemerocallis* and the color is most pleasing. This hybrid has *H. aurantiaca major, H. Thunbergii, H. aurantiaca,* and *H. flava* for its four grandparents!

At the left of this large flower is a flower of *H. aurantiaca,* directly above is a flower of the well-known form of *H. fulva,* and at the right is a flower of the lemon-colored *H. Thunbergii.*

Above, at the extreme right, is a flower of the variety *luteola* which is a hybrid between *H. Thunbergii* and *H. aurantiaca major.* The flower is larger than that of the *Thunbergii* parent, is a light shade of golden yellow but is without the reddish tinges of the *aurantiaca* parent.

At the upper left is shown a flower of the variety Florham, supposed to be of American origin. It has flowers of golden yellow in a shade slightly different from *luteola.*

outer half or two thirds of the petals, quite as in *aurantiaca,* or it may be in streaks, in bands or halos, or in blotches. Different grades of the red may be in the outer three or in the inner three flower segments or the red may be confined to the inner or to the outer three. But thus far no distinct and abundant spotting of red has appeared, such as is seen in various of the true lilies.

The flowers of some of the hybrids have a smooth surface, waxy in appearance; others have a velvety appearance due to minute finger-like elevations of the cells of the surface. The flowers of numerous hybrids glisten brilliantly in sunlight as if the surface were liberally sprinkled with minute grains of gold, a characteristic that is observed also in the species *H. aurantiaca.*

The best of the flowers are " full," with broad overlapping petals that are improvements on many of the older types. Thus the clear yellow shade of color seen in *H. Thunbergii* is obtained in certain hybrids in flowers that are fuller, larger, and more attractive. Increase in the size of flowers is to be had: some hybrids have flowers nearly twice the size of any of the species or of any of the older varieties thus far seen by the writer and in a few cases (see especially the larger flower shown in Figures 2 and 3) the size is combined with rare beauty and fullness of flower.

Considerable range is seen in general stature and vigor of growth of the hybrids and in the height to which flower stems stand with reference to the tips of the leaves. Some plants, particularly when derived from dwarf parents, are quite dwarf. The most showy and floriferous plants are those that stand with flower stems about three feet tall and only slightly overtopping the leaves, quite as shown in Figure 1. Seedlings with taller and more upright flower stalks are common but are less effective because the flowers are elevated above the leaves with a foot or more of bare stems exposed in a somewhat awkward and ungainly effect. This is one of the defects of the old *fulva.*

The season of bloom for the hybrids corresponds in some degree to that of the respective parents. As a rule hybrids with early-blooming parents, such as *Hemerocallis Dumortierii* and *flava,* are earlier in their blooming than are hybrids with *Thunbergii* and *aurantiaca.* Some of the hybrids have bloomed late in the season so it may be that varieties can be developed which extend the season of the day lilies. At The New York Botanical Garden the best of the seedlings give a succession of bloom with the climax in July just following the season of the irises.

In the improvement of the day lilies, getting a single plant with suitable habit of growth and with flowers of a new and desirable type is the important thing. It is then very readily and rapidly propagated vegetatively by division as a " clonal " variety quite as irises and dahlias are propagated. In such a case the entire

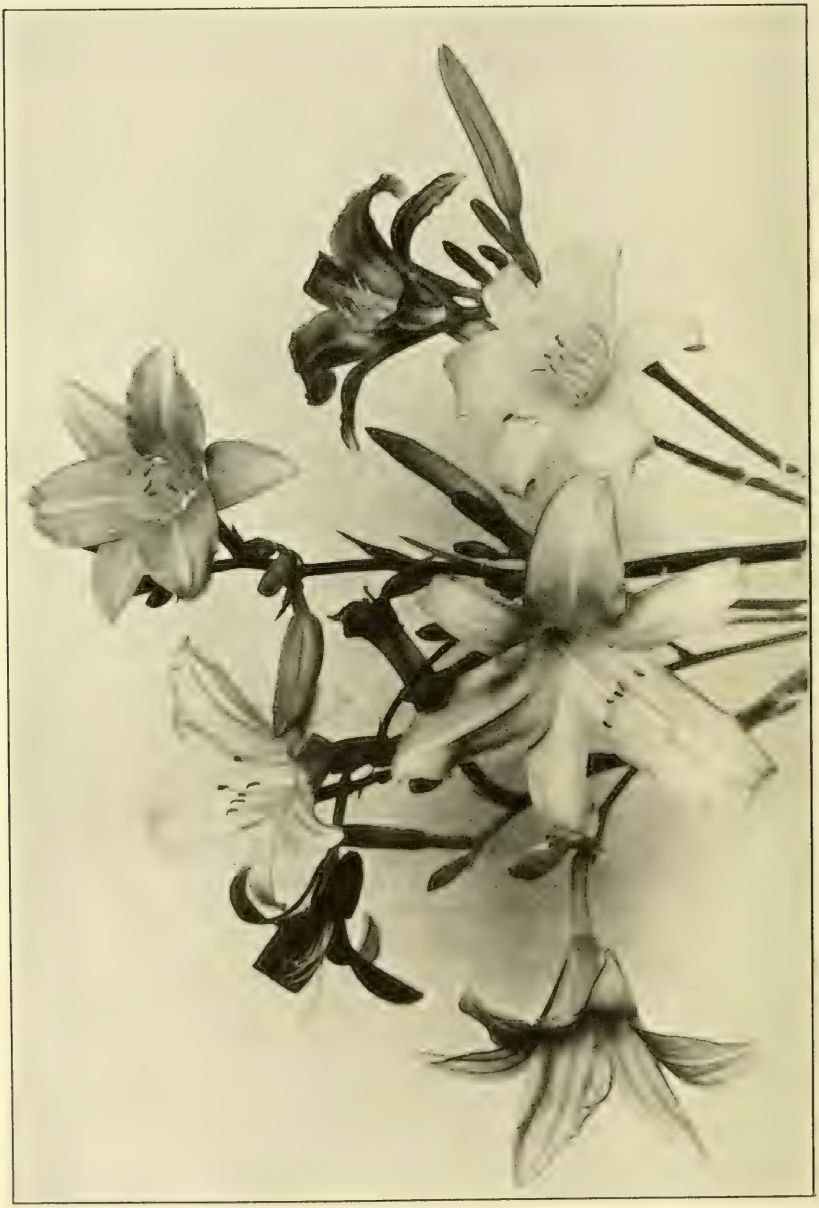

FIGURE 3. (See opposite page for explanation.)

variety is, in reality, one plant whose parts have been separated and grown in different localities. Thus the standard of the variety is assured for the method of its propagation does not involve the variation that is sure to come when there is the seed propagation of hybrids.

It will readily be understood how an entire clonal variety may be self-fruitless. When the original seedling plant happens to be self-incompatible and unable to set fruit and seeds to its own pollen all the plants obtained by dividing its roots and stems are necessarily self-sterile and also pollinations between them are no more effective than are pollinations from flower to flower on any one of the plants as grown. And so many of the clonal varieties of the day lilies are self-fruitless throughout, as were the original seedlings. Certain varieties are, however, more or less self-fruitful. In *Hemerocallis* cross-incompatibilities between seedlings of the same species, or between members of a set of hybrids are also very general and so the clonal varieties developed from them are cross-sterile. Hence failures to set seed to many pollinations both self and cross are very frequent and persistent in the day lilies which one may grow.

FIGURE 3. Here is shown (on opposite page) the range in the size of the flowers in the various hybrid day lilies recently produced at The New York Botanical Garden. Some suggestion of the coloring is given by the shading. All are rather "full" flowers and are among the best of the seedlings selected for propagation.

A rather small flower of the darkest shade of red yet seen in any day lily is shown at the upper left. The flower standing uppermost has a most delicate coloring and is to some persons the first choice of all the seedlings. Below it and to the right is a flower with colors somewhat as in *H. aurantiaca* and just below this is a full flower with waxy sheen and a clear light yellow. At the extreme left is a somewhat trumpet-shaped flower of good size and of a pleasing orange color, tinged with a faint halo of red. In the center is the same large flower shown in Figure 2.

Seven different species and varieties were involved in the parentage and grandparents of this group of hybrids.

All the species of *Hemerocallis* in the trade are propagated vegetatively. There are therefore clonal strains in all the so-called species in cultivation. The old familiar *fulva* has been propagated exclusively as a clonal variety for at least 500 years. Apparently all the plants of it now growing or ever grown in Europe and America are merely parts of one plant! Some study will be needed to determine to what extent the day lilies described as species are really good species or are merely clonal strains.

Day lilies have a place in the flower garden. There is scarcely a group of flowering ornamentals that can be grown so easily in the temperate regions and is so free from insect pests and fungous diseases. Although a single flower usually lasts but one day there is a succession of flowers day after day and large well-developed plants, such as shown in Figure 1, will produce a large number of flowers during many days of bloom. The attractive grass-like foliage comes early in the season and remains fresh and green until autumn. The day lilies are especially effective in mixed border plantings to which they will contribute a mass of rich coloring in their due season.

Possibly the progress thus far made in the improvement of the day lilies is, after all, a mere beginning. Now that crosses involving *Hemerocallis fulva* have been accomplished, perhaps further hybridization will more readily follow. Many new colors or color patterns are possible—such as pure white and blotched or spotted types of flowers. At any rate the breeding of these day lilies at The New York Botanical Garden will be continued and extended and attention will be given to the production of new double-flowered types. The most desirable of the new forms will be propagated as clonal varieties, named, and in due time distributed.

A. B. STOUT.

SEEDS: THEIR TRICKS AND TRAITS[1]

The fairy tale of the germination of three thousand year old wheat from the tombs of the Egyptian Pharaohs was exploded some years ago. Authentic records show that wheat under usual conditions of storage does not retain its vitality over twenty years. Many records on the other hand show very much greater longevity than this for various other seeds. Not the least interesting of these records is one just published by Ohga, a Japanese botanist. He has excavated from the Pulantien Plain of South Manchuria

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[1] Abstract of an illustrated lecture given in the Museum Building of The New York Botanical Garden on Saturday afternoon, July 18, 1925, by the Director of the Boyce Thompson Institute for Plant Research.

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Plantations of thousands of native and introduced trees, shrubs, and flowering plants.

Gardens, including a beautiful rose garden, a rock garden of rock-loving plants, and fern and herbaceous gardens.

Greenhouses, containing thousands of interesting plants from America and foreign countries.

Flower shows throughout the year—in the spring, summer, and autumn displays of narcissi, daffodils, tulips, irises, peonies, roses, lilies, water-lilies, gladioli, dahlias, and chrysanthemums; in the winter, displays of greenhouse-blooming plants.

A museum, containing exhibits of fossil plants, existing plant families, local plants occurring within one hundred miles of the City of New York, and the economic uses of plants.

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Exploration in different parts of the United States, the West Indies, Central and South America, for the study and collection of the characteristic flora.

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Public lectures on a great variety of botanical topics, continuing throughout the year.

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The Capsules, Seeds and Seedings of the Orange Day Lily

A. B. STOUT

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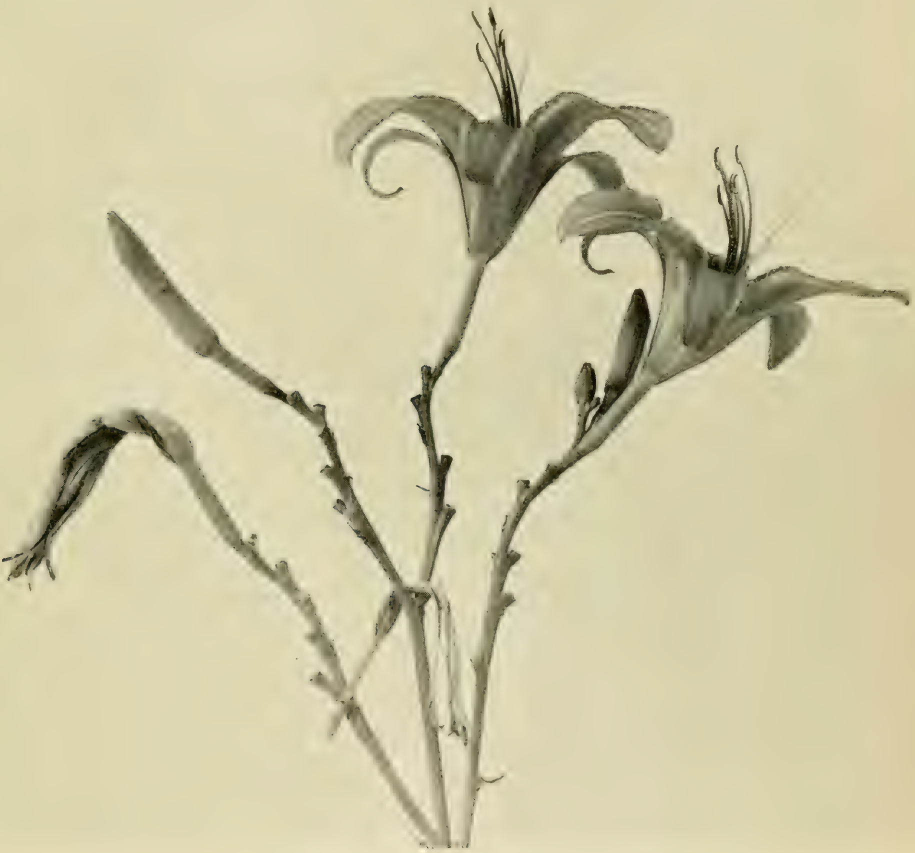
THE CAPSULES, SEEDS AND SEEDLINGS OF THE ORANGE DAY LILY

A. B. Stout
New York Botanical Garden



FLOWERS OF ORANGE DAY LILY

Figure 2

All plants of the orange day lily (*Hemerocallis fulva*) are completely self-fruitless. Day after day the plants bloom profusely. The flowers are perfect, with a pistil and a set of stamens present and fully developed in each flower. But they yield no capsules and seed to careful self-pollination or to pollination from flower to flower among plants of the variety. The flowers merely wither to the very base and soon fall leaving conspicuous spurs with scars as shown above.

THE orange day lily (*Hemerocallis fulva*) exhibits one of the most obstinate cases of sterility or unfruitfulness known among flowering plants. For many years this plant has been grown widely as an ornamental in both Europe and America where in many localities it has escaped and become naturalized. Yet all this propagation has been exclusively through the division and separation of the fleshy roots and rhizomes and never by seed reproduction.

In assembling day lilies for experimental study at The New York Botanical Garden, plants of the *fulva* type have been obtained from various widely separated points in Europe and America. These plants have all been identical in every character. They have all failed to set capsules to self-pollinations and for some of the plants such pollinations have been made in large numbers each year over a period of ten years. The flowers are perfect with a pistil and stamens present and apparently fully developed in each. Pollen is produced in abundance and in artificial culture it germinates well. But every plant of the *fulva* type has been completely self-incompatible.

All pollinations between plants of the *fulva* type have likewise failed to yield a single capsule. All the plants of the entire population of the *fulva* type are inter-sterile.

The facts noted above lead to the obvious conclusion that all the many plants of the orange day lily are merely parts of one original seedling. They constitute a *clonal* variety in distinction to species and varieties propagated by seeds and breeding true under such propagation. The clonal variety is, of course, very frequent among horticultural plants. It originates as a single seedling or bud variant which is ever afterward propagated vegetatively. When the original seedling is completely self-fruitless from any type of inherent sterility the many plants of the entire clon are inter-sterile for the simple reason that pollination between plants is the same as pollination from flower to flower on a single plant. The condition of complete sterility within a clon is common among horticultural plants when there is sterility either from intersexes or from self-incompatibility.

All the various named horticultural varieties of *Hemerocallis* are clonal varieties. Many of them are as fully self-fruitless as is the *fulva*. Nearly all of them, or perhaps all of them, are of hybrid origin and can hardly be expected to breed true to seed in case they do produce seed to selfing.

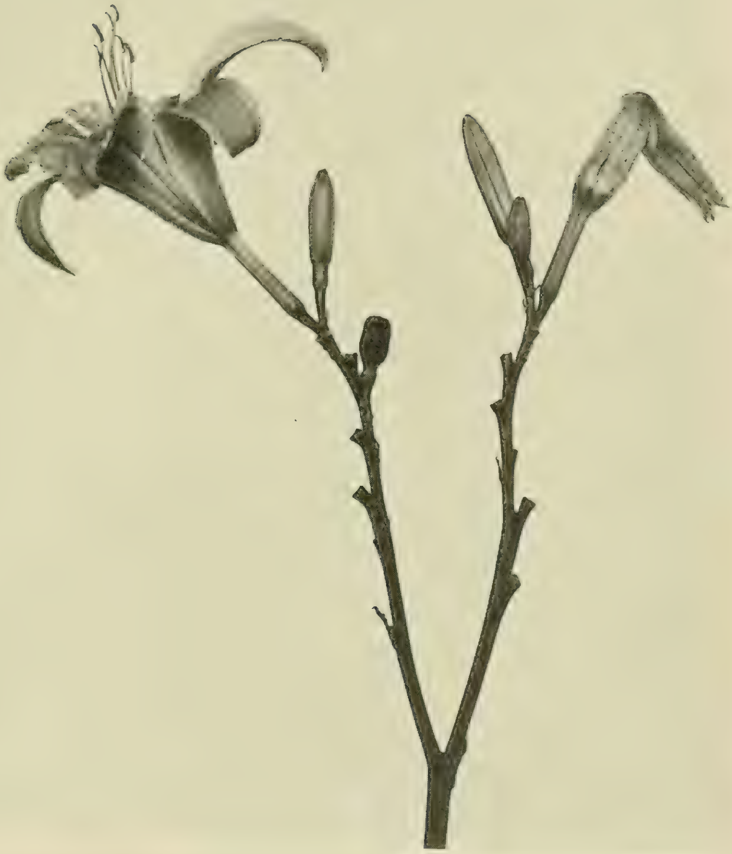
There seems to be some uncertainty as to the extent to which the true *fulva* is in cultivation in Japan and China and also as to whether it is to be found there in a really wild condition. The writer has received living plants of *Hemerocallis* from Professor Albert N. Steward of the University of Nanking, China and from Professor T. Susa and Professor Y. Hoshino of the Hokkaido Imperial University, Sapporo, Japan. These plants were all sent as *fulva* but they are obviously different than the true *fulva* and they differ among themselves.

It is to be noted that many plants grown from seeds obtained from China and that living plants obtained from China have very generally been found to differ from the *fulva* of long cultivation and have been given such varietal names as *maculata, Hupehensis* and *Cypriani* or have been called a distinct species (*H. Forrestii*). Probably all these forms should be included with *fulva* in a single species that is merely variable in nature. At least one of these varieties, the *maculata*, has yielded seed rather freely and has been used by Willy Müller of Naples, Italy, in crosses with *H. citrina*.

Eighteen of the plants received from Japan and China have bloomed. All but two appear to be self-incompatible but they produce capsules and seeds to certain cross-pollinations which is a behavior characteristic of the seedlings of many species having this type of sterility.

Fulva as a Seed Parent in Crosses

But the plants of the *fulva* clon have also been decidedly unfruitful in cross-pollination with other types of day lilies. For many years *H. fulva* and *H. flava* have been widely grown together in gardens yet there seems to be no



CROSS POLLINATION CAUSING PARTIAL DEVELOPMENT

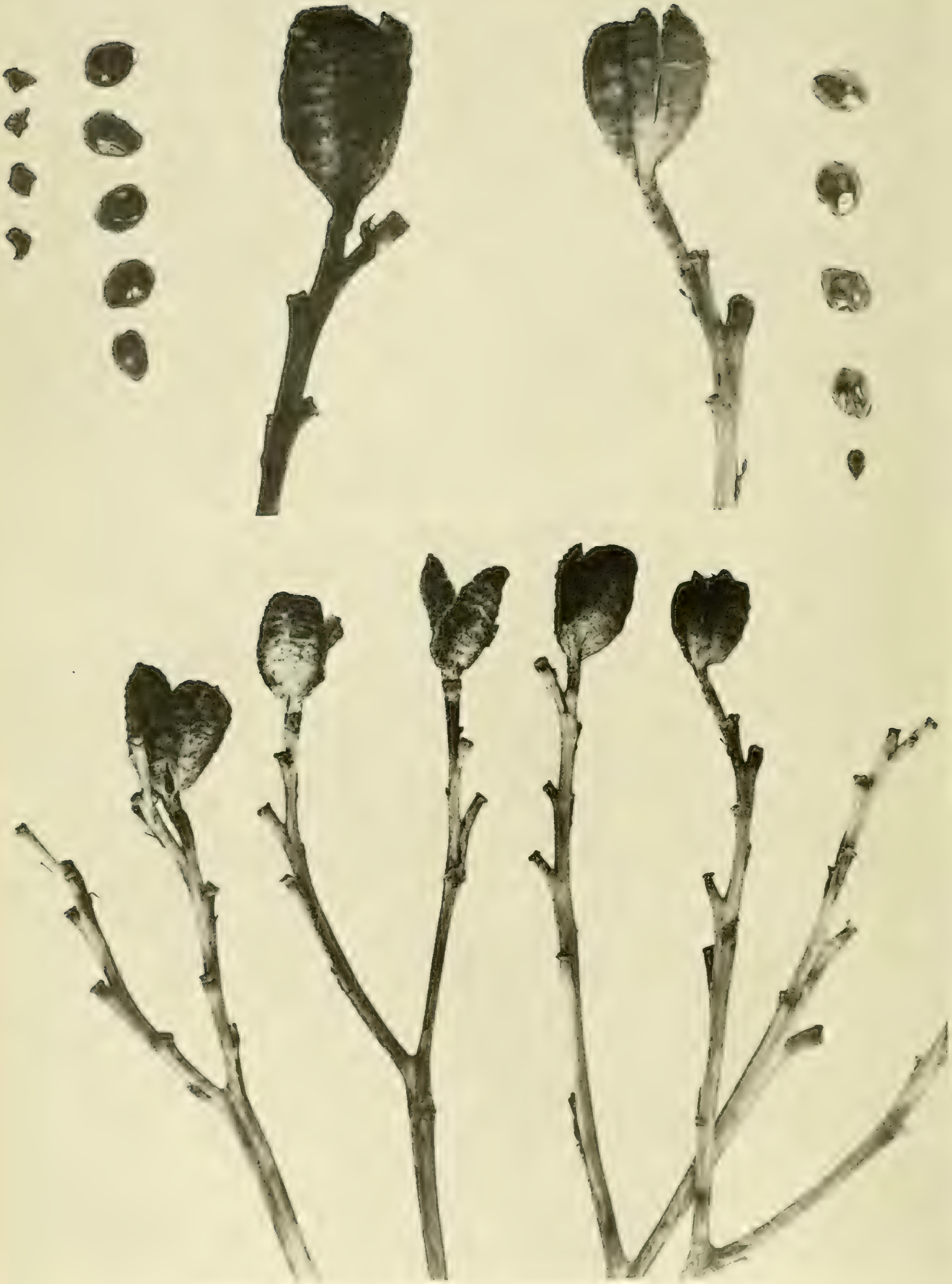
Figure 3

Frequently capsules start to develop on the *fulva* day lily when its flowers are cross-pollinated with pollen of certain types of day lilies. But when such capsules are about one-third matured (see above) they nearly always wither and fall. The foreign pollen thus merely stimulates a partial development of capsules, an effect not seen in the self-pollination of *fulva*.

record that any of the plants of *fulva* have ever produced seed. From time to time collections of different species and varieties including the *fulva* have been grown together under conditions that favor cross-pollination by insects. For ten years plants of *fulva* have been thus grown at The New York Botanical Garden without producing a single capsule to the open pollinations that may have occurred.

Various breeders of day lilies have attempted to secure seed from *fulva* through cross-pollination by hand. One of these Mr. George Yeld[4] reports as follows:

> As to *H. fulva,* I have many times used pollen of it, but never with success, and it, moreover, refuses to seed. I have looked for seed of it in many places—in Auvergne, in Switzerland, in Northern Italy, near Naples, in Cicily, in the Lipari Islands, in Northern Asia Minor, in Trans-Caucasia;

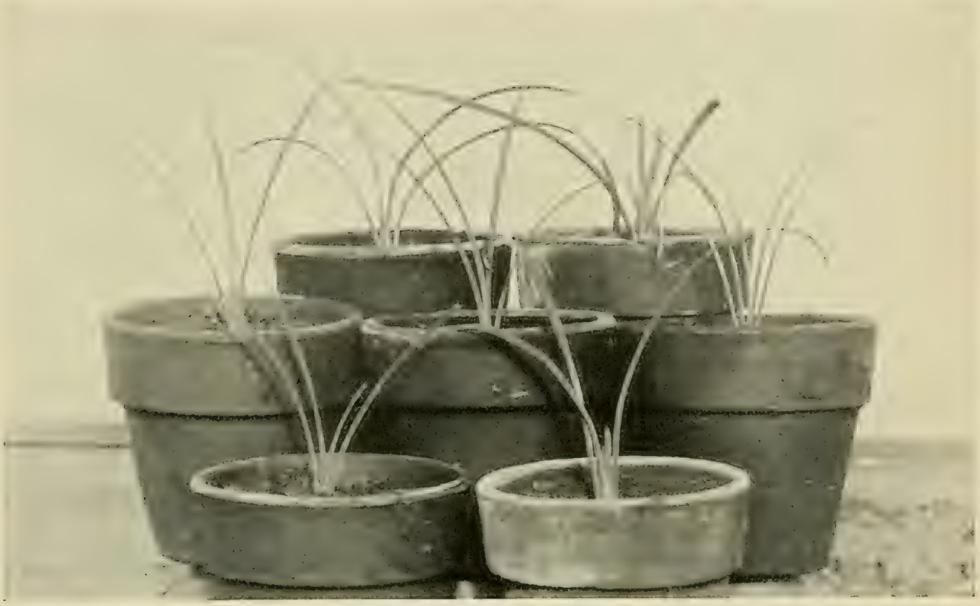


CAPSULES PRODUCED BY CROSS-POLLINATION

Figure 4

(*Above*) Two of the capsules with seeds matured by plants of *fulva*. The one at the left is from cross-pollination with a plant from Japan, the capsule at the right is from pollen of *H. citrina*. As here shown the number of fully developed seeds in these capsules is small. Usually there are also some shrivelled seeds with half developed and dead embryos.

(*Below*) Five mature capsules produced by plants of the *fulva* day lily. Twenty-three capsules are all that have been obtained in over ten years of work during which 7,135 flowers of *fulva* were cross-pollinated.



SEEDLINGS OF FULVA
Figure 5

Including the single seedling recently grown by Amos Perry, these seedlings with four others not here shown are apparently the first and the only seedlings ever obtained from the *fulva* variety of day lily. These are all hybrids with *fulva* as a seed parent. The two at the rear have for their pollen parent a wild plant from China somewhat resembling the true *fulva*. The three in the middle row have as the pollen parent the well known *H. Thunbergii*, which has flowers of a lemon yellow color. The two at the front are from pollen of the rather recently introduced species, *H. citrina*.

but I have never yet found a single pod, and fairly persistent inquiries have failed to bring to light an instance of its seeding.

Evidently many similar efforts to secure seed of *fulva* have failed for there appears to be no successes reported previous to those recorded by the writer[1,2]. The first of these seeds obtained from *fulva* were from the pollen of *H. Thunbergii* and they did not germinate. Efforts to obtain capsules with viable seeds were continued with such success that at this date plants of the true *fulva* have matured 23 capsules containing a total of 70 seeds apparently fully mature and from this seed eleven seedlings are now being grown. Only two other authentic records of seed produced by the *fulva* variety have been found by the writer, either in printed records or through a rather extended correspondence. In a letter dated Nov. 18, 1925, Mr. Amos Perry, well known nurseryman of Enfield, England, lists a variety "Maggie Perry" as derived from the cross *fulva* × *fulva* var. *Cypriana*. In a letter dated Jan. 22, 1926, Dr. J. R. McLeland, of Pleasanton, Kansas, writes as follows:

> I have never been able to cross *Hemerocallis fulva* with anything that would do more than make it set empty seed pods, with two exceptions when I used pollen of *H. citrina* I got two pods with one seed each but neither germinated.

Among the various persons who have undertaken to breed day lilies there may be others who have obtained seed and even seedlings of *fulva* but of whom the writer has not heard.

But plants of the *fulva* do not readily yield seed to cross-pollination with the other species and varieties of day lilies. It has been necessary to make many pollinations to obtain the few seeds secured at The New York Botanical Garden. Of 527 flowers carefully pollinated with pollen of *H. aurantiaca* only two mature capsules and four seeds were obtained and these seeds did not germinate. From 1,763 flowers pollinated from *H. Thunbergii* only nine capsules were obtained with 19 seeds of which six germinated. With pollen of *H. citrina,* 421 flowers of *fulva* have been pollinated but only eight capsules matured with 32 seeds of which three germinated. There were complete failures for 33 flowers pollinated from *H. Dumortierii,* for 121 flowers pollinated from *H. flava,* and for 570 flowers pollinated from the horticultural variety *luteola*. Many cross-pollinations also failed with pollen of the double-flowered varieties *H. fulva Kwanso* and *H. fulva flora-pleno.* The *fulva* clon has been unfruitful to pollen of every one (51 in number) of the seedlings thus far used in the tests. Pollen of fourteen plants from Japan and China has been used in pollinating flowers of *fulva*. In one combination 105 flowers gave one capsule and five seed, from another involving 107 flowers two capsules and 9 seed were obtained and from another combination involving 75 flowers one capsule and two seed were had.

The total number of flowers of *fulva* cross-pollinated in all combinations is 7,135. These have yielded only 23 mature capsules and 70 seeds of which eleven have germinated.

Fulva as a Pollen Parent

The *fulva* variety is the pollen or male parent of certain hybrid seedlings some of which have appeared in the trade. The first of these of which the writer has record were from the cross *H. flava* × *H. fulva,* and were produced at the Botanical Garden of the University of Strasbourg, France. Six hybrids, presumably of this parentage were offered for sale in a trade list issued July, 1910, by Willy Müller, Nocera Inferiore, Naples, Italy. Through correspondence with Mr. Müller and with Professor Karl Killian of the University of Strasbourg the writer learns that several hybrids were obtained with *fulva* as the pollen parent, that some of these were crossed with *fulva* as the pollen parent but that during the recent war the breeding was discontinued and with the death of the head gardener (a Mr. Muller) and of Professor Solms Laubach the records of the parentage of the remaining plants were lost. Through the kindness of Professor Killian the writer has received from Strasbourg living plants of the *H. flava* × *H. fulva* hybrids and also of what is labelled as a hybrid between *H. graminea* and *fulva*.

The hybrids between *flava* and *fulva* obtained at The New York Botanical Garden were first reported several years ago[1,2] and again mentioned in a recent publication.[3] To the present time seven of these hybrids have bloomed. Six other hybrid seedlings have been obtained from the cross *H. citrina* × *H. fulva* and two others have resulted from using pollen of *fulva* on a hybrid between *H. flava* and *H. aurantiaca*. The pollen of the double-flowered variety *Kwanso* used on a hybrid of *flava* × *fulva* has also yielded two seedlings. But to obtain these seventeen seedlings many flowers have been pollinated.

Other seedlings with *fulva* as the pollen parent are to be mentioned. A recent letter from Amos Perry, Enfield, England, lists for sale the hybrid clonal variety "George Yeld" as a cross between *H. citrina* and *H. fulva.* Mr. B. Y. Morrison of the Bureau of Plant Industry, Washington, writes that he has seedlings obtained from *fulva* pollen on two plants of questionable identity Mr. C. Betscher of Dover, Ohio, states in letters received in November, 1925, that he has used pollen of *fulva* and *flava Kwanso* in securing certain hybrids but whether in controlled pollinations or not is not stated.

At The New York Botanical Garden the hybrids of *H. flava* × *H. fulva* and of the double cross (*flava* × *aurantiaca*) × *fulva* have themselves been crossed with *H. aurantiaca*, *H. citrina*, *H. Thunbergii*, the varieties *Florham* and *luteola*, and with several plants from China and Japan so successfully that over 1,200 seedlings have been obtained all having the *fulva* as one or two of the grandparents. Most of these plants have not reached blooming age but most of those that have bloomed possess flower colors which show the *fulva* parentage. Flower colors similar to certain of the *fulva* offspring have, however, been obtained in hybrids between species and varieties other than *fulva*, so on the basis of flower color alone seedlings of unknown parentage are not necessarily to be ascribed to *fulva*.

Conclusion

The history of the cultivated day lilies known as *Hemerocallis fulva* may be reconstructed as follows: Perhaps more than a thousand years ago a Chinese gardener saw a single seedling day lily, either wild or in a garden, which he deemed worthy of propagation. Its habit of spreading by rhizomes made vegetative propagation simple and rapid. As the seedling happened to be fully self-incompatible, the condition of the great majority of all day lilies, vegetative propagation was necessary. In time the clon became widely cultivated even in Europe and America and continues to set no fruit to self-pollination or to pollination between the various plants.

It might appear from the decided fruitlessness of this clonal variety that the apparently perfect pistils of the flowers are only rarely perfect enough to function in fruit setting. The pollen is, however, abundant and gives good germination in artificial culture yet it has thus far functioned in only a relatively few of the many crosses in which it was used.

The day lilies as a group, the species, the varieties and the numerous seedlings already studied, are decidedly fruitless to self-pollination. Many crosses between them fail completely. In a relatively few cases individual seedlings and clonal varieties are self-fruitful. Certain crosses between self-sterile plants are highly productive of seeds. It is clear that the sterilities of the group involve chiefly incompatibilities, both self and cross, in the processes of fertilization. In such cases fertilization is selective and discriminative; the pollen and the pistils are highly functional in certain relations but not in others. Capsules and seeds are produced when compatible pollinations are made.

Thus far the *fulva* clon has been completely self-incompatible and in its crosses with other day lilies, both as a seed and as a pollen parent, the compatibilities are of a weak grade and only successful in a very low percentage of the flowers pollinated. It seems very probable that highly compatible cross relationships will be found, possibly with some of the seedlings now being grown or with plants that now exist in China or Japan, and that then the plants of *fulva* will yield capsules and viable seeds abundantly and at the will of the pollinator.

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The New York Botanical Garden

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THE FULVOUS DAYLILIES—I

1. THE HEMEROCALLIS FULVA CLON EUROPA

The oldest and the best-known of the fulvous daylilies is the one commonly cultivated under the name *Hemerocallis fulva* L. This single-flowered daylily was described by Lobel in 1576 (Historia) as having cinnabar-red coloring in the flowers and as being in this particular very distinct from the yellow-flowered daylily (*H. flava*), which was also then in cultivation in Europe. In 1601, Clusius (Plantarum Historia) states that this plant was being grown in many gardens throughout Austria and Germany. Nearly two hundred years later, Linnaeus (1753) considered this daylily as a hybrid, but a few years afterward (Species Plantarum, ed. 2, 1762) he gave to it the specific rank and the name *Hemerocallis fulva* which have since been accorded to it.

But the plants of this particular daylily do not produce seeds to any kind of pollination possible for them alone. They are evidently never able to do so because of a complete self-incompatibility in the processes of fertilization. The propagation of this daylily is by division. All the plants of it are merely branches derived from one original seedling and hence they constitute a *clon* and not a species or a variety that reproduces true to type by seeds. This distinction was not recognized by Linnaeus, but it is necessary to make the distinction if one is clearly to understand the true status of those groups of plants, both in culture and in the wild, that have arisen from a single individual by repeated vegetative division. The *Hemerocallis fulva* of Linnaeus, which was in cultivation in Europe for at least one hundred and eighty-six years before his date of naming it as a species (1576 to 1762), and which has continued in cultivation for one hundred and sixty-five years since that date—a total of over three and a half centuries—exists solely as a clon.

The question arises whether this clon, the *H. fulva* of Linnaeus, is represented among the wild daylilies and is itself typical of a natural species. Botanical and horticultural explorations and studies in Japan and China, beginning about the year 1700 and continuing to the present date, have revealed various fulvous daylilies, but the exact counterpart of the *H. fulva* of Linnaeus has not been discovered as a wild plant. Nor does there seem to be any conclusive evidence that it has been included among the daylilies recently in cultivation in the Orient. On certain of the fulvous daylilies found, there were bestowed such names as *H. fulva* var. *Kwanso, H. disticha* Donn, *H. disticha* var. *flore-pleno, H. longituba* Miq., *H. fulva* var. *longituba* Maxim., *H. fulva* var. *angustifolia* Baker, and *H. fulva* var. *maculata* Baroni. Thus the rather marked differences between the various fulvous daylilies found in the Orient and the *H. fulva* of Linnaeus were recognized. However, conservative botanical treatments, such as that of the Index Kewensis, have included all the various forms mentioned above in the one species, *H. fulva.* These rather diverse forms are to be recognized as valuable material for use in breeding, especially since the fulvous daylilies seem destined to play an important rôle in the development of new red-flowered daylilies valuable for garden culture.

It is time to review the different fulvous daylilies in respect to their identity and interrelationships. The knowledge now available regarding their natural distribution in the Orient is meagre and inadequate. An attempt may be made to recognize the types of them that are now known both as wild and as cultivated, and to comment on their botanical relationships and their horticultural status. In doing this the botanical status and the horticultural status of each should be clearly considered. Those that are merely clons should be recognized as such. Possibly this may lead to a better understanding of what the wild species are like.

The horticultural name "Europa Daylily" is here suggested for the single-flowered fulvous daylily which has been in continued cultivation in Europe at least since the first description of it by Lobel more than 350 years ago. This is historically the Linnaean type of the species *Hemerocallis fulva.* But this particular plant is a clon and it is very doubtful if its exact counterpart exists among the wild plants of the Orient. The true botanical status of the clon is simply that of the one original seedling selected for the first propagation. This status is better expressed by using a clonal name botanically, such as *Hemerocallis fulva* clon Europa, or merely by using the horticultural name Europa Daylily, than by continuing to use *only* the species name bestowed by Linnaeus.

The Europa Daylily probably arose as a single somewhat aberrant seedling, either wild or in garden culture, which attracted the attention of some Oriental gardener. Possibly the fullness of the flowers and the somewhat bold pattern of their coloring were outstanding qualities. The plant happened to be completely self-

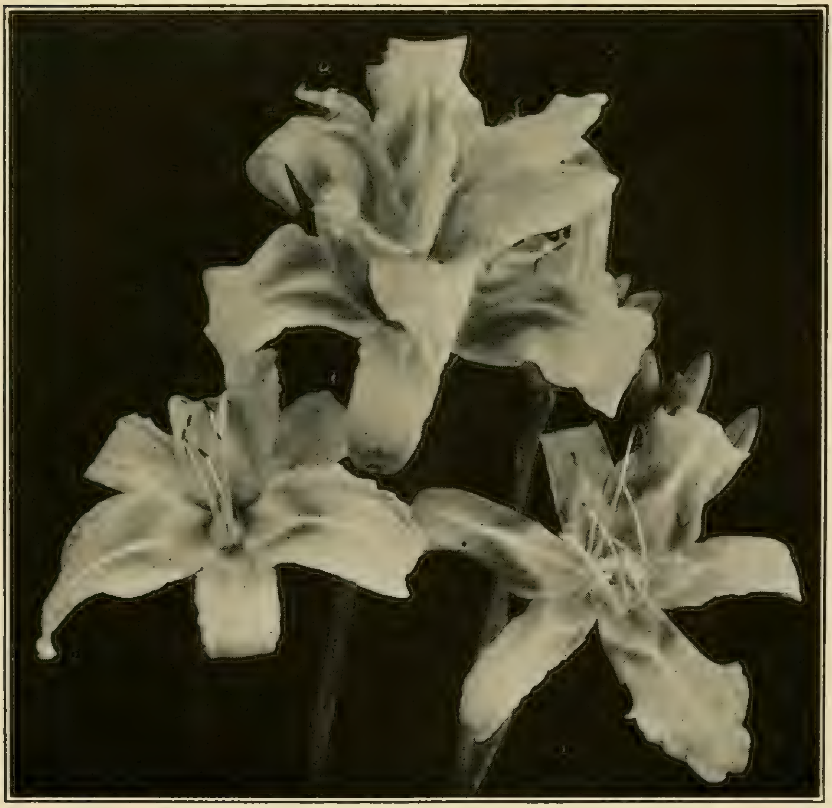

FIGURE 4. At lower left, simple flower of the Daylily Europa; at lower right, a semi-double flower from a plant chiefly bearing such flowers; above a very double flower. All are fulvous daylilies with almost identical coloring.

incompatible—a type of sterility very common in daylilies. But it also happened to have the habit of spreading vigorously by rhizomes and this made vegetative propagation easy and has maintained the individual character of the original seedling throughout several centuries of garden culture. This clon remains today in vigorous growth and is thus a demonstration that long-continued asexual reproduction does not of itself necessarily reduce vigor and lead to degeneration. We may perhaps assume that the Daylily Europa had its origin in the Orient, together with the Lemon Daylily (*H. flava*). How and when these two found their way into garden culture in Europe as reported in 1567 are at present apparently matters of conjecture.

A plant of the Europa Daylily is among the most robust of daylilies. In coarseness of foliage and vigor of growth it is surpassed only by the double-flowered form. The dome of leaves reaches a height of about three feet. The leaves are light green, strongly distichous in arrangement, and rather coarse. The plant extends itself vigorously by widely spreading rhizomes. The roots are numerous, and some are enlarged or fleshy. The strong scapes are stiffly erect to a height of about 50 inches, are branched at the summit, and bear as many as 15 to 20 flowers.

The flowers have a fulvous overcast of color in the outer zone of the open flower with reticulated veins of darker shades. An arching mid-zone of darker shade in the petals is a conspicuous feature. The throat of the flower is orange only. The petals are rather thin, slightly wavy along the margin, and of delicate texture, yet they retain form and color well during the day. The segments are rather broad and overlapping, giving a full flower.

The capsule, produced only rarely and to the compatible fertilizations of certain cross-pollinations, is about one inch in length, broadly ovate, with the apex truncate and indented.

The persistent self-unfruitfulness of the entire clon of the Europa Daylily makes it impossible to obtain selfed seedlings of the clon. Its sterilities in cross-relations are also so decided that it is only within very recent years that the clon Europa has been used successfully in hybridization with other daylilies.

2. THE DOUBLE-FLOWERED FULVOUS DAYLILIES

The varietal names "*Kwanso*" and "*flore-pleno*" have been given to double-flowered daylilies that are very closely related to the Daylily Europa. The first record of such a daylily is by Kaempfer, a physician and botanist who was among the first of the Europeans to live in Japan. In his volume on Japanese plants (Amoenitatum Exoticarum . . . Descriptiones, 872. 1712) he mentions an " Iris " and briefly describes it as having large double flowers of the color of fire. But he gave the Japanese names for it (Ken, Quanso, and Wasrigusa), through which the plant was identified later by Thunberg (Flora Japonica, 1784) as a *Hemerocallis.*

A Japanese work on plants (Somoku-Dzusetsu, 2nd edition, **6**: 13. 1874) gives an uncolored illustration from a drawing of a double-flowered daylily named Yabukwanzo. In a later edition this plant was identified as *H. fulva* L. var. *Kwanso.* Various publications on Japanese plants mention this double-flowered fulvous daylily as rather widely cultivated in Japan.

The first introduction into Europe of a double-flowered fulvous daylily was by a Rev. W. Ellis, who brought living plants from Mauritius. The firm Veitch & Son exhibited this plant under the name *H. disticha flore-pleno* before the Floral Committee of the Royal Horticultural Society in London during 1860, receiving for it a First Class Certificate (Gard. Chron. **1860**: 482). A year later a colored plate was published (The Floral Magazine **1**: *pl. 13*) which is in very poor coloring but shows a flower that is much doubled. The excellent volume which surveys the botanical and horticultural contributions of the Veitch firm mentions (Hortus Veitchii, 446. 1906) the daylily introduced from Mauritius as *H. fulva* var. *flore-pleno* and says of it " A semi-double form of the common Day Lily, with spikes of orange flowers similar in color to the type, possessing the important quality of remaining longer on the plant."

Soon after the introduction of the fulvous Daylily Flore-Pleno by Veitch & Son, plants known as *H. fulva Kwanso* were brought into Europe directly from Japan by von Siebold. The first mention of this plant appears to be a mere note in the Gardeners' Chronicle (**1864**: 654) that a plant of " *Hemerocallis Kwanso foliis variegatis* " had been exhibited. Two years later a plate in good color, showing the double flower and the white-striped or variegated foliage of this plant was published (Gartenflora **15**: *pl. 500.* 1866).

The Gardeners' Chronicle in 1867 (32: 292) speaks of this plant introduced by von Siebold under the name *Hemerocallis Kwanso flore-pleno* and states that it " is merely a variety of *H. fulva,* with the leaves more or less distinctly marked with white stripes, and the tawny-red flowers filled out with a tuft of smaller petaloid segments in the center."

Thus it appears that the *H. fulva Kwanso* first introduced was variegated as well as double-flowered. The variegation is evidently of the chimeral type and plants with this type frequently produce all-green branches. Hence it may well be that some of the double-flowered plants with all-green foliage now in cultivation arose from the Kwanso Daylily.

The propagation of these two daylilies is solely by vegetative means. It can not be otherwise, for the pistils of the flowers are entirely impotent. The two types are merely clons.

It is generally considered that the clon of the Daylily Flore-Pleno introduced by Veitch & Son is less double than the Daylily Kwanso. It is to be noted, however, that these conditions are exactly reversed in the first illustrations of the two. The plate of von Siebold's plant published in 1866 (Gartenflora, *pl. 500*) shows a semi-double flower, while that of Veitch's plant (The Floral Magazine 1: *pl. 13*) shows a flower much more double. The writer has obtained entirely green-leaved plants under both names Kwanso and Flore-Pleno from various nurserymen and from various botanical gardens. These have been grown side by side for comparison and study. There seems to be no difference in the color of the flowers and the various aspects of the habit of growth. Some plants, however, have all flowers very double, while other plants have semi-double flowers, with also many inter-grades; various grades of doubleness may be found on the same plant.

In 1924 Mr. Henry H. White, of the Department of Agriculture, American Presbyterian Mission, in Anhwei, China, sent to The New York Botanical Garden living plants of daylilies which he had collected from an old abandoned cemetery. These plants have green leaves and bear flowers of various grades of doubleness with many flowers only semi-double.

When plants of the Europa Daylily are grown beside plants having double flowers the former are earlier to bloom, have foliage somewhat less coarse, and have taller scapes. The color of the flowers is the same. The zone or eye spot is, however, less developed in the smaller and inner accessory segments of the double flowers than in their more primary segments and in the petals of the single-flowered Daylily Europa.

Of the origin of the double-flowered type there is no record. It was in existence in Japan in 1712 and it is known to be now rather widely distributed in Japan and probably also in China, both in culture and as an apparent escape, evidently quite as the Daylily Europa now exists in such old-settled areas as Long Island about abandoned homesites, along roadsides, and wherever the activities of man have given the plant a chance to spread vegetatively. All the distribution of the double-flowered fulvous daylilies in the Orient as well as in Europe and in America has been by vegetative propagation. The very close relationship between the double-flowered types Kwanso and Flore-Pleno and the single-flowered Daylily Europa is obvious. The double-flowered type probably arose either directly from the Daylily Europa as a bud-sport, or it may have been a seedling member of the same race. Some evidence bearing on the origin of these rather anomalous types of fulvous daylilies will undoubtedly be obtained from the character of the seedlings derived from using them in cross-breeding.

The double-flowered daylilies have not become popular garden flowers. The color of the flowers is perhaps too dull. The flowers also seem monstrous, coarse, and lacking in pleasing symmetry. As in the case of the double-flowered true lilies (*Lilium tigrinum flore-pleno,* for example), they are not very attractive. Besides, the flowers stand rather high above the leaves. Possibly double-flowered daylilies may yet be developed with sprightly colored and more symmetrical flowers, and with a more pleasing habit of growth.

3. Fulvous Daylilies with Variegated Foliage

Thunberg in his volume on Japanese plants (Flora Japonica, page 142), published in 1784, makes mention of a white variegated variety of what he called *Hemerocallis fulva.* He also speaks of varieties with simple and with double flowers but does not say which had the variegated foliage. A daylily with variegated leaves is mentioned in 1829 (Roemer & Schultes, Systema Vegetabilium) as a variety of *H. disticha* and since a variety with " pleno " flowers is also mentioned one might infer that the variegated plants were single-flowered. In the various descriptions of the double-flowered fulvous daylilies usually there is no mention of variegated leaves. In 1864, The Gardeners' Chronicle (page 654) mentions the display of a "*Hemerocallis Kwanso foliis variegatis*" and states that it was a " well-marked variegated plant, very near the variegated variety of *H. fulva*." Evidently the *H. fulva Kwanso* introduced from Japan by von Siebold was both double-flowered and variegated, according to the plate of it published in 1866 (Gartenflora **15**: *pl. 500*) and the early description of it.

From time to time after 1866 two sorts of variegated daylilies have been mentioned. One with single flowers is usually called *H. fulva variegata*; one with double-flowers is generally known as *H. fulva Kwanso variegata.* The latter has been spoken of as " almost as striking in appearance as the well-known *Pandanus Veitchii,* which at first sight it somewhat resembles " (Gard. Chr. **51**: 681. 1882).

The variegated daylilies are seldom offered in the trade either in single or in double flowers. It is possible that plants of one or of both of the variegated forms exist in certain gardens in America, but if so the writer has not heard of them. Through the special efforts of Director Fred J. Chittenden, of the Royal Horticultural Society Gardens at Wisley, England, The New York Botanical Garden has at last received plants of variegated daylilies, which, however, are yet to come into bloom.

There appears to be no accurate description by which one may determine whether the flowers of the single-flowered variegated daylily are like those of the Daylily Europa or are different. For a more precise description and a correct naming of the clon or the clons of the variegated daylilies, the flowers are necessary.

A. B. Stout.

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THE BULB- OR STEM-NEMATODE (TYLENCHUS DIPSACI KÜHN) AS A PEST OF PHLOX

G. STEINER AND B. O. DODGE

THE FULVOUS DAYLILIES—II. THE WILD FULVOUS DAYLILIES OF THE ORIENT

A. B. STOUT

THE COCONUT-PALM—COCOS NUCIFERA (Concluded)

JOHN K. SMALL

GIFT OF A MEMORIAL GARDEN BENCH

NOTES, NEWS, AND COMMENT

ACCESSIONS

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THE FULVOUS DAYLILIES—II. THE WILD FULVOUS DAYLILIES OF THE ORIENT

In a preceding article[1] three groups of cultivated fulvous daylilies, including several clons, were discussed and the question raised as to whether any one of them is duplicated or even closely represented in the wild. The double-flowered clons Kwanso and Flore-Pleno and the variegated forms are, it would seem, of horticultural origin and existence. It is certain that the Linnaean type of *Hemerocallis fulva* was in cultivation in Europe at least as early as 1576, and as this particular type exists only as a horticultural clon it has been suggested[1] that it be known as *H. fulva* L. clon Europa or simply as Daylily Europa. What the natural relatives of this clon are like is a matter of special interest from the standpoint of both botany and horticulture, and with this in mind the fulvous daylilies of known wild origin and of close relationship to the Daylily Europa may be surveyed.

THE HEMEROCALLIS DISTICHA OF DONN

Evidently no fulvous daylily other than the clon Europa found its way into Europe until about 1798. Record of such a daylily is found in a catalog of the plants in the Cambridge Botanical Garden, England, published in 1804 by James Donn. The name *H. disticha* is given, but the only description is the one word "spreading." No statement is made of the origin of the plant, but the date of the introduction is recorded as 1798. Donn also lists the *H. fulva* of Linnaeus; hence it is certain that his new species *H. disticha* was different from the Europa Daylily.

No description of the *H. disticha* appeared until 1823, when a colored plate was published by Sweet (British Flower Garden, *pl. 28*). The flower is described as light-brown-orange in color, the perianth-tube as 1½ inches long, and the segments as lanceolate, spreading, and about 3½ inches in length. The plant illustrated was obtained from a nursery in England, but it is stated that it was of a type native in China and that plants of this type had been in cultivation in England for some time, although they were seldom known to yield flowers. The description and the colored plate make it clear that this was a fulvous daylily which was new and somewhat distinct from the old *H. fulva* of Linnaeus.

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[1] Stout, A. B. The Fulvous Daylilies—I. Jour. New York Botanical Garden **30**: 129–136. 1929.

It is a strange coincidence that David Don in 1825 (Prod. Florae Nepalensis) lists under the name *Hemerocallis disticha* a daylily which he reports to be growing wild in Nepal. Don had seen a mere reference to the *H. disticha* of James Donn, but evidently did not know of the description and colored plate published by Sweet. Since Don describes his plant as having yellow flowers it seems certain that he did not have a fulvous daylily.

It may be noted that frequently references to the fulvous daylily *H. disticha* of Donn and of Sweet are, by omission of the final " n," credited to " Don."

THE HEMEROCALLIS LONGITUBA OF MIQUEL

In 1867 the Dutch botanist Miquel described certain dried herbarium specimens as a new species, *Hemerocallis longituba.* He was not certain whether the plants had been collected as wild or as cultivated in Japan or elsewhere. The color of the flowers was supposed to have been pale fulvous. The most characteristic feature of the flowers is the length of the perianth tube, said to be 1 to 1¼ inches long. Miquel makes no mention of the *H. disticha* of Donn and of Sweet, the perianth-tube of which is equally as long.

THE HEMEROCALLIS FULVA ANGUSTIFOLIA OF BAKER

The next type of daylily that was considered to belong with the species *H. fulva* was described under the varietal name *angustifolia* in 1871 by Baker (Jour. Linn. Soc. **11**: 359). Baker describes his plants as very small, with scapes scarcely a foot tall, and with leaves only 12 to 18 inches long and only 2 to 4 lines wide. The segments of the flowers are described as narrow and acute; but there is no mention of color.

Baker based the description on dried specimens which he states came from (1) Khasia, India (in the Hooker Herbarium), and (2) Guriev and Karabagh, collected by Fischer. Guriev is near the extreme northwestern side of the Caspian Sea, and Karabagh is further south and in Caucasia.

In a volume on Japanese plants by Matsumura (Nippon Shokubutsumeii. 1884), *H. fulva* var. *angustifolia* Baker is listed and the Japanese name Ki-suge is given, but what this plant was like I am not able to determine and it does not appear to be included in any other list of Japanese plants. In a later volume (Index Plantarum Japonicarum 2: 198. 1905), Matsumura makes no mention of this variety in listing the kinds of daylilies known for Japan.

There is no evidence submitted by Baker that the flowers of these specimens had an element of fulvous coloring. For all we know this dwarf form with narrow leaves may be related to one of the types recently described as *H. Forrestii, H. nana,* or *H. plicata.* Baker's plants may be disregarded in considering the fulvous daylilies, and especially any type to be included with the *H. fulva* of Linnaeus or to be considered as closely related to it.

THE H. FULVA LONGITUBA OF MAXIMOWICZ

The Russian botanist Maximowicz described in 1885 (Gartenflora 34: 98, *pl. 1187*) and illustrated with a colored plate certain daylilies of a type obtained from the wild in the Hakone Mts. of Japan and said also to be in cultivation in Japan. The flowers are described as orange-yellow with slight fulvous tinges and as having the perianth-tube long and narrow. This type is described as different from the *H. fulva* of Linnaeus (the clon Europa) in having narrower leaves, and flowers with less fulvous color and a longer perianth-tube. The description by Maximowicz is followed by a note by E. Regel, Director of the Botanical Garden in St. Petersburg, stating that in good garden soil these wild plants differ from the old form of *H. fulva* chiefly in having a long perianth-tube.

THE HEMEROCALLIS FULVA CLON MACULATA

Of all plants thus far obtained from the wild in the Orient, the one giving rise to the clon Maculata is most like the Daylily Europa. The coloring of the flowers is only slightly different; the fulvous shades in the outer half of the opened flower are slightly paler and the arching band across the mid-section of the petals is slightly darker. The flowers are larger than those of Daylily Europa and the petals are of a different shape. The plants are later in the period of blooming, but they are very similar in habit of growth except that the scapes are slightly

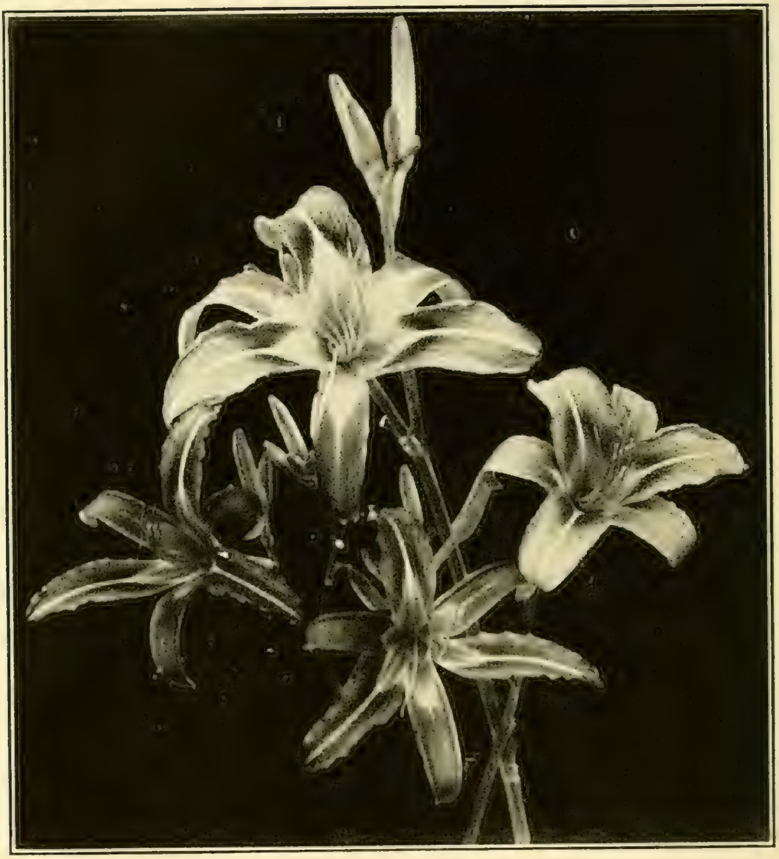

Figure 5. Flowers of fulvous daylilies: at right, the old familiar *H. fulva* clon Europa; above, the *H. fulva* clon Maculata; below and at left, of two wild plants from the Orient. There is much variation in the shape of the petals and in the degree and the shade of coloring but the general color pattern is quite the same.

shorter. A colored plate showing a flower and a capsule of this clon has recently been published in Addisonia (14: *pl. 460*).

The origin of this Daylily Maculata is well known. Padre Giraldi sent to Florence, Italy, seeds or living plants from wild stock growing near Shen-si, China. Either one plant was grown or one plant was selected as the best among several different plants. This was propagated, and was soon grown at the botanical garden in Florence. Plants of this clon came to the attention of Professor Baroni, who described them as *"H. fulva* var. *maculata"* (Nuovo Giorn. Bot. Ital. II. 4: 306. 1897). Soon thereafter plants of this clon were obtained by C. Sprenger in Naples for distribution to the trade. The New York Botanical Garden has been favored with living plants of this stock by Willy Müller, nephew of C. Sprenger, who was associated with him in nursery work and who still continues this business in Naples. Plants have also been obtained from other nurserymen who have offered the Daylily Maculata for sale. All these plants have been identical in every particular. They are all self-fruitless and they set no seed to pollination among themselves. They can be propagated only by division and they very clearly belong to one clon and for this reason the name Maculata may be used as a clonal name instead of as the botanical designation for a natural variety.

In several respects the Daylily Maculata is a more attractive garden plant than the Daylily Europa. Its flowers are larger, the color-pattern is slightly more bold in its contrasts, and the scapes are somewhat shorter, which brings the flowers slightly nearer to the foliage.

The Hemerocallis fulva clon Hupehensis

This clon was derived from a seedling plant grown by C. Sprenger in Naples, Italy, from seed collected by Padre Cypriani in Hupeh, China. The first published mention of the clon appears to be in the Gardeners' Chronicle in 1906 (III. 40: 158), where the flower is described as "reflexed, undulating, bright coppery red, with yellow throat."

The H. fulva clon Cypriani

This clon has the same source and history as clon Hupehensis. Sprenger evidently selected for propagation two seedlings, grown from the seed obtained from China, or it is possible that he only obtained two seedlings from the seed that came to him from China. This clon has flowers described by Müller (Gard. Chr. III. 40: 159) as "coppery red with a golden centre and a well marked golden line down the middle of the petals. The form is gracefully reflexed."

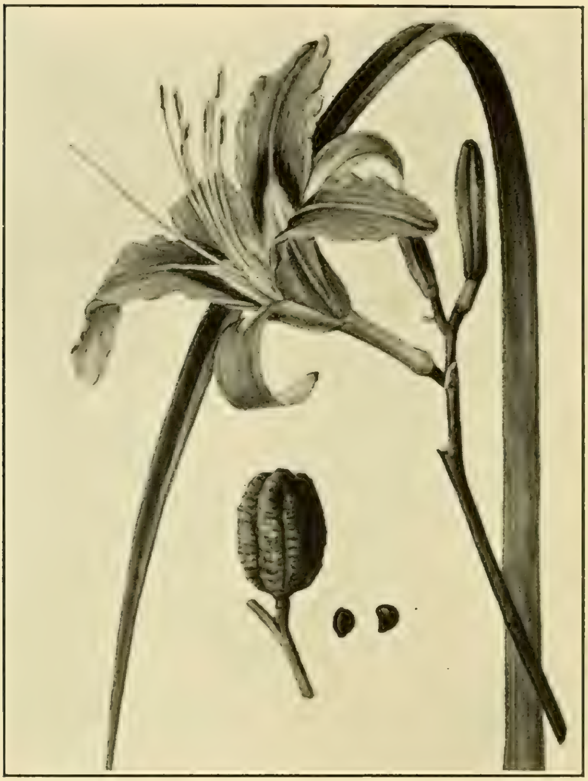

Figure 6. A wild plant from China, showing the short perianth-tube and the broader petals almost as in the Europa Daylily. The color is, however, a fine sprightly red that approaches pink, with a darker eye-zone.

FULVOUS DAYLILIES OF WILD ORIGIN GROWN AT THE NEW YORK BOTANICAL GARDEN

The most reliable information regarding the character of the wild fulvous daylilies which the writer has been able to obtain has been secured by the study of living plants brought from the wild state in the Orient and grown for several years at The New York Botanical Garden. From Dr. A. N. Steward, of Nanking University, there were obtained 17 different seedlings collected at Kuling, China, and 20 plants from Purple Mountain near Nanking, China. Also 31 different plants were obtained from several localities near Sapporo in the island of Hokkaido, Japan, through the kindness of Professor Y. Hoshino and Professor T. Susa of the Hokkaido Imperial University.

These plants are all very much alike in general habit of growth. The leaves are light green, medium coarse, strongly distichous, and ascending-curving. The scapes stand at a height of about four feet. Compared with the Daylily Europa, they have foliage that is less robust and scapes that are somewhat shorter. There is, however, the same feature of spreading rhizomes and the capsules are of the same type.

In respect to the precise character of the flowers there is much variation among these plants. For the majority of them the flowers have a long perianth-tube and the segments are long and narrow (see FIGURE 7). All have some shade of red in the coloring of the face of the flower and in most cases there is a darker zone just outside of the throat of the flower. The plants from Japan have the duller and more brownish shades; some of those from Kuling have bright shades of pink and red. The flowers of one plant are coral-red in general color with an arching zone of garnet-red in the midsection of each petal.

Individual plants in any one of these groups from Japan, or from Kuling, or from Purple Mountain in China may be selected which agree closely with the *H. disticha* of Donn and of Sweet, or with the *H. longituba* of Miquel. Others are almost identical with the *H. fulva* clon Cypriani named by Sprenger. For a few of the plants the shape of the flower (see FIGURE 6) is nearly the same as that of the Daylily Europa (the *H. fulva* of Linnaeus), but no plant is a duplicate of the Daylily Europa or as near to it as the *H. fulva* clon Maculata.

THE FULVOUS DAYLILIES IN THE LITERATURE OF ORIENTAL PLANTS

Various botanical treatments by Japanese botanists and by Europeans who have observed or collected plants in Japan and China make mention of fulvous daylilies. For example, the woodcuts published by Iinuma in 1874 (Somoku-Dzusetsu, 2nd ed. vol. 6) illustrate two types later identified by Makino (Somoku-Dzusetsu 3rd ed. 1910) as *Hemerocallis fulva* L. var. *Kwanso* Regel and *H. fulva* L. var. *longituba* Maxim. In various lists of species the names *H. fulva* and *H. disticha* are given and

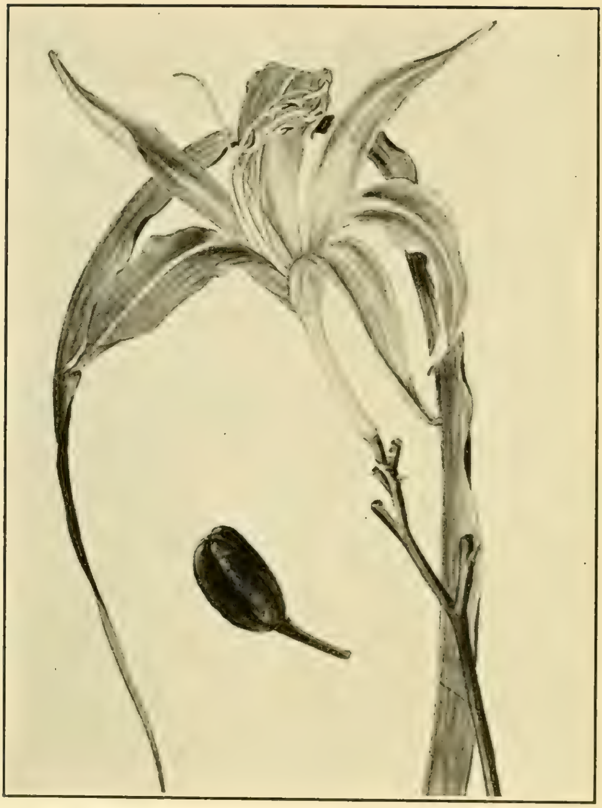

Figure 7. A wild plant from China, showing the long perianth-tube, and narrow segments. In comparison with the flower shown in Figure 6 there is less of an eye-zone and the colors are paler and more fulvous. This is the type of flower described as *H. disticha* by Donn and by Sweet, as *H. longituba* by Miquel, and as *H. fulva longituba* by Maximowicz. Figures 5, 6, and 7 show well, except for portraying the shades of color, the variations in the flowers of plants that are at present included in the species *H. fulva.*

in a few cases both names are included in one list. In most cases, however, all the single-flowered types of the fulvous day-lilies other than the *H. aurantiaca,* which will be discussed in a later article, are included in the name *Hemerocallis fulva,* but by some writers they are all called *H. disticha* and in a few instances the names listed are *H. fulva* and *H. fulva* var. *longituba.*

In none of these descriptions and lists is there a critical discussion of the types and variations that were observed, and adequate descriptions and comparisons of the cultivated and the wild types are not made.

CONCLUSION

It is clear that the wild fulvous daylilies of the Orient which are most closely related to the *Hemerocallis fulva* clon Europa are a variable group of plants. There are wide variations in the shape of the flowers and in the degree and the shade of the fulvous or red colorings, even among plants of the same locality. Such variations have given rise to the several names discussed in this article. Judging from the living plants obtained from the wild, it would seem that the type described as *H. disticha* by Donn and by Sweet includes fully the *H. longituba* of Miquel and the *H. fulva longituba* of Maximowicz. The plant *H. fulva* L. clon Europa is rather closely approached in respect to the shape of flower and general coloring by some of the wild plants but is not duplicated.

For the wild plants there are two extremes in the shape of the flowers: the one with a short perianth-tube and usually broader segments; the other with a long tube and narrow segments. Possibly a more complete knowledge of the natural distribution of these forms may reveal that there are really two distinct species which are more or less intermingled and hybridized in certain areas. At the present time it will, perhaps, be best to include the variations here discussed, both of the wild and of the cultivated plants, in the one species *H. fulva* L., of which the clon Europa is the historical type. If a botanical name is to be used to designate the type with a long perianth-tube, the proper combination is *H. fulva* var. *longituba* Maxim. With this treatment the name *H. disticha* of Donn and of Sweet and the name *H. longituba* of Miquel become synonyms.

The individual seedlings that are brought from the wild and propagated asexually, as several have been, give rise to clons and hence, in several cases at least, the scientific names applied to such clons may now be used merely as horticultural names.

While the exact counterpart of the *H. fulva* of Linnaeus (the clon Europa) has not yet been discovered among the wild daylilies, plants very closely related to it have been found. Evidently the original seedling which was propagated to give the Daylily Europa was one of this group of fulvous daylilies.

Some of the variations among these daylilies of the species *H. fulva* are certain to be of value in culture and in the breeding for new horticultural types. Already in the breeding work at The New York Botanical Garden the plants with pink and red colorings in the flowers have been used in selective breeding and seedlings obtained that are of sprightly and pleasing shades of bright red.

A. B. Stout.

THE COCONUT-PALM—COCOS NUCIFERA*

Later Planting and Intensive Cultivation in Florida

After the activities described in the preceding paragraphs had subsided, a second period of interest in the coconut was ushered in by the developments inaugurated and carried on by Commodore W. J. Matheson on Key Biscayne and other places in southern Florida. The following description of the activities at Key Biscayne have been furnished by the Honorable Hugh M. Matheson, who is in charge of the planation.

" The soil of Key Biscayne is generally a loose, calcareous sand, with a small amount of humus, giving it a slightly dark color. The fresh-water table stands, on an average, about three feet below the surface of the ground. Just above this water table is calcareous marl or hardpan. Before exposing this hardpan to the air, it can easily be penetrated by roots and cut with a spade. When exposed to the air, it becomes quite hard and makes an excellent road-dressing. The best results obtained in planting coconuts occurred where the water table did not exceed two feet below the surface of the ground. The fresh-water table fluctuates with tide, both daily and seasonal, and also with the seasonal rains.

" The native growth found on the Key was practically all saw-palmettos of enormous size, mixed with other growth, such as sea-grapes, cabbage-trees, and poison-wood. The best results in coconut planting were produced on rather low land thickly covered with large saw-palmettos. The soil seems to have been poorer where the proportion of native growth was small, the scattered saw-palmettos being heavily mixed with sea-grape and poison-wood.

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* Continued and concluded from Jour. N. Y. Bot. Gard. **30**: 153–161. Jl 1929.

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CHROMOSOME IRREGULARITIES IN RELATION TO STERILITY IN HEMEROCALLIS FULVA CLON EUROPA

BY

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CHROMOSOME IRREGULARITIES IN RELATION TO STERILITY IN HEMEROCALLIS FULVA CLON EUROPA*

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Aomori Agricultural Experiment Station, Japan

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INTRODUCTION

Plants of the single-flowered fulvous daylily, commonly and widely cultivated as *Hemerocallis fulva,* are decidedly sterile by an abortion of the majority of both the microspores and the macrospores. It is the cytological study of the nuclear phenomena associated with this sexual impotence that is to be reported in this paper, and this study has become chiefly an analysis of the behavior of the chromosomes and of their multiplication not only in meiotic divisions but in somatic mitosis as well.

In considering the significance of the cytological data from these plants, it should be remembered that all the plants of this particular type of daylily are propagated, and evidently always have been propagated, only by vegetative means. This is necessary because for them there is a complete incompatibility between such of the germ cells as are functional. Evidently the many plants of this one type of daylily, which are now growing rather widely throughout the world either as a cultivated plant or as a frequent escape, constitute a single clon. The various cytological studies that have thus far been reported for plants named as *Hemerocallis fulva* involve, it appears, only plants of this commonly cultivated single-flowered clon and hence relate to the various branches of one seedling plant.

Two double-flowered types of the fulvous daylily, described as var. *Kwanso* and var. *flore-pleno,* that are obviously very closely related to the single-flowered clon, are also in cultivation. Single-flowered plants presumably belonging to this same species are to be found growing wild in the Orient. Some of these, such as the *H. fulva* clon Maculata have more recently been introduced into garden culture. During the last few years a considerable number of plants of the wild stocks of this species have been obtained directly from Japan and China and are being grown at The New York Botanical Garden for study and for use in breeding (Stout, 1925). Thus far all such plants have been observed to differ in some particular from plants of the commonly cultivated single-flowered clon that is known as *H. fulva,* although in some of these plants the differences are slight. The plants of these wild stocks also differ among themselves. Thus it appears that the species to which this clon is most closely related and in which it is evidently to be included comprises several varieties or races.

The plants of the type commonly cultivated and widely known as *H. fulva* are, so far as we are able to determine, uniform to an unusual degree. Living plants of this type obtained from such widely separated localities as Italy, France, Holland, Sweden, England and various sections in the United States have been grown together at The New York Botanical Garden and have been carefully compared. These plants are all indistinguishable. The studies to be reported in this paper relate primarily to this vegetatively propagated and widely cultivated clon of the single-flowered fulvous daylily. These plants will be referred to as the "*H. fulva* clon Europa."

At least twenty different papers have already been published which deal with various aspects of the cytology of plants of this clon Europa. In several of these papers it is reported that in these plants frequently more than four pollen grains are formed from one pollen mother cell. This fact was reported for this clon as early as 1882 by both Tangl and Strasburger. Tangl (1882) concluded that these extra pollen grains arise after the reduction divisions have been completed by the further divisions of certain of the cells of the quartet. Strasburger, later in the same year (1882), showed that irregularities appear in the first meiotic division by the lagging of chromosomes, which then form small accessory nuclei. Further and more extended studies were made by Juel (1897), who found irregularities in the distribution of the chromosomes and in the formation of the nuclei both in the first and the second meiotic divisions.

In general these papers present an excellent account of the irregularities that result in the unequal distribution of chromosomes, in the lagging of chromosomes and in the formation of micro pollen grains. These earlier authors, however, did not settle the question as to what the normal and basic number of chromosomes is for plants of this clon, and what is the range and the method of the variations in number beyond and below that which is normal.

Our studies show that the basic diploid chromosome number for plants of the clon Europa is 12, but that the number may increase both in somatic and in meiotic divisions, and that during micro-sporogenesis increases in the number of chromosomes and of chromatin units are combined with irregularities in their distribution, with other abnormalities in nuclear division, and with the erratic organization of nuclei until finally there is an abortion of spores that is almost complete.

CHROMOSOME BEHAVIOR IN SOMATIC DIVISIONS

The Basic or Normal Number of Chromosomes

The normal number of chromosomes in the somatic cells of plants of the Europa clon is 12. During the stages of nuclear division in somatic cells the chromosomes are long rod-shaped structures very uniform in size, and each is clearly a single chromosome and not a group of two or more chromosomes. In these figures the chromosomes are often rather closely aggregated and more or less intertwined. But whenever the chromosomes are spread out in an *early* stage of the equatorial plate sufficiently to admit of accurate count, the number has been found to be most frequently 12 as shown in Pl. I, Fig. 1. But the chromosomes may, in some cases at least, divide and separate quickly and very completely, so that one can best determine the correct somatic number during the early stages of the equatorial plate (Pl. I, Fig. 1), or later in the anaphases when all the chromosomes have completely divided and the two sets are fully separated (Pl. I, Fig. 2).

Irregularities in the Number of Chromosomes in Somatic Cells

For many cells in the embryonic regions of the root tips and of the stems the distribution of the daughter chromosomes during the anaphases is regular, resulting in the passing of 12 chromosomes to each daughter nucleus (Pl. I, Fig. 2). However, cases of unequal distribution involving non-distribution* of certain pairs of daughter chromosomes are to be found which result in daughter nuclei with the numbers 11 and 13, or of 10 and 14. Still greater inequalities of distribution are to be seen. Especially when cells are of asymmetrical shapes, they may divide in such a way that only a few chromosomes pass to one pole. This is shown in Pl. I, Fig. 3, in which there is a normal total of 24 chromosomes in an anaphase stage, but non-distribution is so general that 19 chromosomes are collecting at one pole. Thus in a single mitosis of a somatic cell that had 12 chromosomes, the number of chromosomes which a daughter nucleus may receive may rise to at least as many as 19.

In the division of nuclei which have previously received an increased number of chromosomes, further non-distribution of chromosomes may occur, giving nuclei with varying numbers of chromosomes above the normal of 12, and in some cases the number may rise to more than double the normal diploid number.

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* The term "non-distribution" will be used in this paper to designate those cases either in somatic or in meiotic divisions where two daughter chromosomes form and separate by the splitting of a mother chromosome, but are not distributed to different daughter nuclei. The term "non-disjunction" applied by Bridges (1913) will be here employed only for cases where two homologous chromosomes of a pair are not distributed to different daughter nuclei during the meiotic divisions. According to Wilson (1925, p. 872) and to Sharp (1926, p. 400) the term non-disjunction can be applied both to the non-disjunction of homologous chromosomes during meiosis and to the non-distribution of sister chromosomes in somatic divisions, but a distinction as here suggested seems highly desirable.

An extended search has been made in somatic tissues prepared by the paraffin method in the effort to determine for plants of the Europa clon the frequency of nuclei having increased numbers of chromosomes and the range of these numbers. The counts are most easily made in the late stages of the anaphase of mitosis. In some root tips only the normal numbers of 12 and 12 were found. In other root tips of the same plant, cells with increased numbers of chromosomes were observed intermingled with cells that had the normal number. Division figures, such as are shown in Pl. I, Figs. 2 and 4, were noted side by side in a single root tip, but in most cases the large majority of the cells possessed the normal number. The highest number of chromosomes recorded thus far for the division of any somatic cell is 56 (Pl. I, Fig. 5).

Arber (1920) has reported that the somatic cells in certain portions of the flowering axis of plants of *H. fulva* are commonly binucleated or even multinucleated. Such cells have not been observed by us either in the somatic tissues, where mitosis has been especially studied, or in the pollen mother cells, although they have been noted among the tapetal cells.

CHROMOSOME AND NUCLEAR BEHAVIOR DURING SPOROGENESIS

Synapsis

The stages of synapsis have been very carefully studied for various plants of the Europa clon obtained from different localities in Europe and America. In every plant the synapsis of pollen mother cells was very uniformly normal. Disintegration such as is described by Timm (1928, Abb. 1) was not found to a noticeable degree in the nuclei of spore mother cells. Also, in no case were two resting nuclei or two synaptic knots noted in a single spore mother cell. Special study was made of this point, for it is important to know whether the presence of two nuclei in pollen mother cells is a factor in the increase in the number of chromosomes observed in later stages, as is reported to be the case by Karpechenko (1927) for certain hybrids between *Raphanus sativus* and *Brassica oleracea.*

The Normal Number of Chromosomes in Diakinesis

During diakinesis the total number of individual chromosomes in many of the nuclei is apparently 12, which is in agreement with the normal diploid number in the somatic cells. These may occasionally be arranged as six bivalents (Pl. I, Fig. 10) but usually there are various numbers of bivalents. The following groupings of chromosomes have been found in this stage: —6 pairs; 5 pairs + 2 single; 4 pairs + 4 single; 3 pairs + 6 single; 2 pairs + 8 single; 1 pair + 10 single; and 12 single, which are all the combinations of bivalents and univalents possible for a total of 12 chromosomes. Nuclei with more than six chromatin masses are frequent in cells that are in the stages of diakinesis and in many cases the number is obviously due to the presence of univalents. Thus in Pl. I, Fig. 7 there are evidently four bivalents and four univalents, making a total of eight chromatin masses involving a total of 12 chromosomes, which is the normal diploid number.

IRREGULARITIES IN THE NUMBER OF CHROMATIN UNITS IN DIAKINESIS AND IN THE FIRST MEIOTIC DIVISION

A study of numerous nuclei in diakinesis and in the early stages of the first meiotic division reveals that many nuclei possess more than 12 masses or units of chromatin. Thus far the highest number of masses observed during diakinesis is 24 (Pl. I, Fig. 9), which was found in an aceto-carmine preparation. In this and in similar preparations many of the masses present are obviously single, but there are also cases of several masses more or less connected. In nuclei at this stage (Pl. I, Fig. 8) certain of the masses present evidently comprise more than the equivalent of two of the smaller masses. Thus the number of chromatin masses present in a nucleus during diakinesis is frequently greater than 12 and there are noticeable irregularities in their relative sizes and shapes.

Possibly the number of chromosomes present in certain pollen mother cells may sometimes be more than 12 due to an irregular distribution in the somatic divisions that precede their formation, such as occurs in the cells of the roots. But such conditions as are shown in Pl. I, Figs. 7, 8 and 9, indicate that there are frequently failures in the reconstruction of chromosomes after synapsis. The evidence is very positive that the breaking up of chromosomes into fragments may and does occur during diakinesis (Pl. I, Figs. 8 and 9). Later, during the early stages of the first meiotic division, fragmentation of chromosomes is also frequent. Thus in Pl. I, Fig. 12 the six bivalents are in the earlier stages of fragmentation and segmentation and in Pl. I, Fig. 16 all the bivalents and univalents are in the process of breaking up into numerous pieces. Later, after the fragments are more or less separated and there is a failure or a delay in the organization of nuclei, the total number of pieces of chromatin may be as high as 50 or more (Pl. II, Fig. 24) and some of these may be very small.

During the first meiotic division an increase in the number of chromosomes may and often does occur by the division (longitudinal splitting) of univalents, such as regularly occurs in somatic divisions and in the second meiotic division. In the equatorial plate of the first division the univalents are often smaller than the bivalents, even when the univalents are in the process of dividing. This is well shown in Pl. I, Figs. 13 and 14, which are of two pollen mother cells lying side by side in the same anther with the nuclei of both in the equatorial plate of the first division. In Pl. I, Fig. 14 there are 12 univalents and each is dividing. In Pl. I, Fig. 13 there are 5 bivalents and 2 univalents. A slightly later stage is shown in Pl. II, Fig. 17, with 12 chromatin masses passing to each pole. Most of these appear to be double due to the beginning of a second splitting. Thus from 12 univalents it is possible that a total of 48 chromosomes may develop by two successive divisions. With complete pairing and no fragmentation there is usually a reduction division, although irregular distribution and non-disjunction may follow. With increasing numbers of univalents the first division becomes more and more like that of a somatic cell. When all 12 chromosomes are univalents and there is division of each in the first division (Pl. I, Fig. 14), a reduction of chromosomes is omitted and the division is identical with that in somatic mitosis. Certain of the figures given by Juel (1897) indicate that he had before him such a condition. It seems probable that it was from observing such figures that Strasburger (1900) was led to decide that the normal diploid number of chromosomes for plants of *H. fulva* (the clon Europa) is 24.

To summarize: during diakinesis and the first meiotic division marked irregularities frequently develop in respect to the number of chromatin units. Through the division of univalents the number may range from the normal 12 to as many as 24. When there is also fragmentation, the number of chromatin pieces may be greater. As a result the numbers in the metaphases of the first division are very often more than 12; they rather frequently rise to 24, and a total of more than 30 is to be found. Further chromosome division and fragmentation in the second meiotic division may again increase the number of chromatin units, although the later splitting of chromosome units is very often not completed, at least when the number has already been increased and especially when the increase has been by the splitting of univalents.

Normal Stages in Sporogenesis

Stages of sporogenesis that are normal in some one particular are frequently to be observed. In Pl. II, Fig. 19 there has been disjunction of all the 6 pairs of chromosomes but 1 chromosome is lagging. In Pl. III, Fig. 32 the shape of the chromosomes is normal and they are in four groups but the distribution has not been equal. In Pl. III, Fig. 34 are shown four sister nuclei of nearly equal size, and each nucleus evidently contains 6 chromosomes that are now greatly increased in size and especially in length, but at least some of the chromosomes may be abnormal, for there are present some of the enlarged X-shaped chromosomes that will be discussed later. A pollen grain with its primary nucleus in mitosis with 6 rod-shaped chromosomes present is shown in Pl. III, Fig. 36, the number being half of the normal number of 12 which is found in the somatic cells of the plant. That the number of chromosomes at this stage may sometimes be greater than 6 is shown in Pl. III, Fig. 37. Thus certain normal conditions are to be noted along with numerous abnormalities at all stages in the processes of sporogenesis.

A development that produces four pollen grains in a tetrad group from one pollen mother cell is, of course, to be considered normal in respect to the number of spores formed. A functional pollen grain is one that will act in fertilization and a fully normal spore is, we may consider, one in which each nucleus possesses 6 chromosomes (Pl. III, Fig. 36). It may, however, be conceived that pollen grains which carry more or less than a complement of 6 chromosomes may function in fertilization. The hybrids obtained with the Europa clon are being studied for evidence on this point.

The Various Types of Irregularities

We may further summarize the irregularities that occur during sporogenesis in plants of the Europa clon as follows: (a) the increase in the number of chromatin units as already described, (b) the irregular distribution of the chromatin units, (c) the development of anomalous shapes in chromosomes, (d) the irregular and abnormal organization of the daughter nuclei, (e) the omission of one of the reduction divisions, (f) the formation of abnormal numbers of microspores with the abortion of many of them and (g) a failure in the proper divisions of the primary or the generative cells in certain of the pollen grains.

IRREGULARITIES IN THE DISTRIBUTION OF CHROMATIN IN THE FIRST DIVISION

Perhaps the simplest phenomenon in the irregular distribution of chromatin is the lagging of a single chromosome in the first meiotic division (Pl. II, Figs. 19 and 20) or the isolation of a pair that has not disjoined. As already stated, this may occur when the number is normal (12 diploid) and there has been complete pairing. A small accessory nucleus may then be formed, as was described and figured by Strasburger (1882). There may be more than one lagging or stray unit. The distribution in the first division may give three or more groups with various numbers in each. A case of three groups with four chromosomes (some already split or fragmenting) in each is shown in Pl. II, Fig. 21. With an increase in the number of chromatin units and of chromosomes during the early metaphases the distribution that follows becomes increasingly irregular.

IRREGULARITIES IN THE FORMATION OF CELL PLATES IN THE FIRST MEIOTIC DIVISION

Cell plates may or may not be formed at the close of the first division. When a plate is fully developed, it results in two cells either with the nuclei organized, permanently or merely for a time, or with the chromatin units scattered. There appear, however, to be few cases where only two spores are formed from one pollen mother cell, hence such conditions as are shown in Pl. II, Fig. 27 are usually followed by the division of at least one of the two cells. Where three or more nuclei are formed after the first division and these become fully separated by cell plates, further division evidently does not occur at least in the case of most of the cells. Most instances of three microspores in a group and some of the instances of four spores of irregular size are the products of only one regular division. In many cases the chromosomes pass on into the second division without the formation or the persistence of definite cell plates (Pl. II, Fig. 30 and Pl. III, Fig. 31). When the number of chromatin units is large, as after fragmentation, the units may lie scattered throughout the cytoplasm (Pl. II, Fig. 24) and the organization of the nuclei is delayed and irregular, the entire group passing on into the second division without the formation of a definite nucleus.

IRREGULARITIES IN THE DISTRIBUTION OF CHROMATIN DURING THE SECOND DIVISION OF MEIOSIS

In the second division or in the final stages preceding the formation of the nuclei, the distribution of the chromosomes is most often irregular even though the shape of the chromosomes is normal and their number is normal or nearly so. Pl. III, Fig. 31 shows a distribution into five groups of 3, 4, 6, 6 and 7 chromosomes that are all quite normal as to shape, the total being 26 or only 2 more than the normal for the four microspores that normally develop. In Pl. II, Fig. 30 four groups composed of 12, 16, 17 and 18 chromosomes are to be seen, and nearly all the chromosomes are of the normal rodlike form. Here the number of microspores that are forming is normal, but the numbers of chromosomes are increased to a total of 63 instead of the normal total of 24 for all the members of a quartet. In such cases there were either fragmentations with divisions of chromatin units in both the first and the second meiosis or the number of chromosomes that entered synapsis was greater than 12.

IRREGULARITIES IN THE SHAPE OF CHROMATIN MASSES

The abnormal shapes that chromatin masses or units very frequently take and retain begin to develop in the late stages of the first division (Pl. II, Fig. 18) and become well developed in the equatorial plates of the second division (Pl. II, Fig. 25). In the latter stage irregular and X-shaped chromatin masses are commonly seen. In the majority of cases each of these appears to be composed of two daughter chromosomes that have remained attached at the middle and have failed to complete a separation. Among the groups of such structures some may be found with the two rods of the X separating quite as do daughter chromosomes while others are much lobed and very irregular in shape. To count these structures as double or as two daughters would in many cases give a total of more than 60 instead of the normal number of 24 for all nuclei of a completed second division.

When these X-shaped chromatin bodies are assembled into two groups after the anaphase of the first division, they may appear as represented in Pl. II, Fig. 25. In this particular figure there are 17 in one group and 13 in the other. At this stage the number for the two groups frequently varies around 30. It was a figure similar to this that led Belling (1925) to believe that there are 33 chromosomes, or three sets of 11, in the somatic cells of plants of the Europa Daylily. Belling, however, made no studies of the somatic divisions.

It is perhaps a significant fact that the X-shaped and apparently double chromosomes have not been found when the total number for the second division is nearly normal—that is when there are but 6 splitting chromosomes for each of the two equatorial plates of the second division and 6, or close to that number, for each of four spores when that number develops from a single pollen mother cell.

The fate of these X-shaped chromosomes or cohering pairs of daughter chromosomes is a matter of interest. That they may remain in this condition and pass into the primary nucleus of spores is indicated in Figs. 33 and 35. But thus far in the mitosis of the primary nucleus of microspores only rod-shaped chromosomes have been noted (Pl. III, Figs. 36 and 37), which may indicate that nuclei receiving the X-shaped chromosomes do not reach this more advanced stage of development, or that the two pairs of the X become separated, or that they combine to make a single rod. The shapes of chromatin masses may be still more abnormal in that they may become much lobed or even almost amoeboid in shape (Pl. II, Fig. 24).

THE STRETCHING OF CHROMATIN MATERIAL BETWEEN NUCLEI

The stretching or stringing out of a single chromatin unit, as described by Juel (1897), is frequently to be seen during both the first and the second division, and this may continue or persist even after the reorganization of the nuclei. In Pl. II, Fig. 22, which is a telophase of the first meiotic division, one chromatin unit is stretched between two daughter nuclei with a part in each. Quite the same condition is shown in Pl. III, Fig. 33 after the nuclei resulting from the second division are fully formed. Evidently the two ends of a single chromosome may be included in two different nuclei, or two daughter chromosomes which have remained attached to each other are thus distributed.

THE MICROSPORES AND MACROSPORES

The Number of Microspores

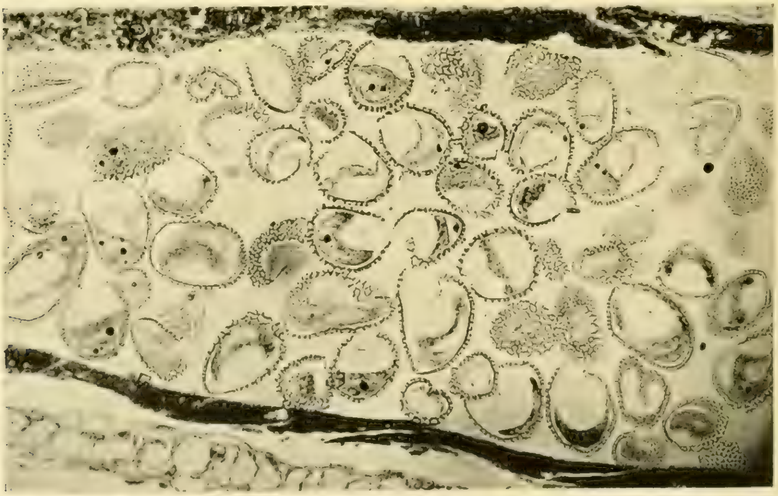
The number of microspores that may develop from a single pollen mother cell has been especially studied in fresh material by using the aceto-carmine method. In only one case has but one large cell been found to be derived from a pollen mother cell. In the cytological preparations of meiosis the chromatin masses frequently lie scattered within one cell with little indication of spindle fibres, but evidently divisions which give two or more spores occur sooner or later. The number of spores formed from a single pollen mother cell and their relative sizes, with the frequency for each in the 624 cases counted, are as follows:—

1 large spore,	1 case
2 large spores nearly equal in size,	3 cases
3 spores of irregular sizes,	18 cases
4 spores of uniform sizes,	119 cases
4 spores of irregular sizes,	174 cases
5 spores of irregular sizes,	198 cases
6 spores of irregular sizes,	84 cases
7 spores of irregular sizes.	20 cases
8 spores of irregular sizes,	6 cases
9 spores of irregular sizes,	1 case

From such a survey it appears that the normal number of four spores is formed from nearly one half of all pollen mother cells, but that in more than half of these cases the spores are irregular in size. In about one-fifth of all the cases four spores of nearly uniform size are formed. The omission of any division, which gives but one spore from a pollen mother cell, occurs rarely.

Variations in the Size of the Microspores

The microspores have been especially studied in cytological preparations made from anthers that were about to dehisce. There is considerable variation in the size of the grains with all gradations between the extremes. The mature dry grains are ovoid in shape with a conspicuous



Photomicrograph of pollen grains in the anther shortly before anthesis, showing the large proportion of undersized and shrivelled microspores.

fold or crease along one side in the long axis. In the sections (see text figure) certain grains are cut in their short axis and hence appear out of proportion to the grains that lie with the long axis in view. A considerable number of the grains are undersized, shrivelled and of irregular shapes. Nearly all of the cells have the exine with its reticulations developed to some degree, and relatively few of these spores are entirely lacking in protoplasmic contents.

The Nuclei and the Chromosome Number in Microspores

In many of the microspores, at the time anthers are about to dehisce, there is a single nucleus, which is in the resting condition and which possibly does not develop further. But division figures for the formation of the vegetative and the generative cells are to be found. In some of these 6 chromosomes are present (Pl. III, Fig. 36); in others more than 6 are to be seen; but thus far the largest number noted has been 18 (Pl. III, Fig. 37). In all these divisions thus far observed only rod-shaped chromosomes have been found. The two-celled stage of the microspore following the division of the primary nucleus is rather frequently seen, with the smaller generative cell lying to one side of and entirely outside of the vegetative cell. In many such microspores further development evidently does not take place.

The Viability of the Pollen

Many tests for the germination of pollen have been made over a period of ten years and involving many plants of the Europa clon obtained from various widely separated countries. There is excellent germination of about 3% of the pollen grains on a medium of 1% agar with 10% or 15% cane sugar. In no test has more than 5% of all the microspores germinated and only well-formed grains of good size have germinated. The viable pollen grains make fine long tubes and, as pollen is abundant in the anthers, it would seem that sufficient viable pollen is produced to yield seed freely when there is a compatible relation in fertilization.

The Abortion of Macrospores

The abortion of the macrospores has not been studied in detail by cytological methods, but the behavior of plants of the Europa clon in respect to seed-setting indicates that abortion is quite the same in degree for macrospores as for microspores. To all self-pollinations there is complete self-incompatibility; the ovaries make no start toward development and there is prompt abscission. In more compatible cross-pollinations the pollen tubes penetrate to the ovules and the ovaries enlarge and develop for some time. Many of these young capsules are entirely empty; some contain only one seed each but these capsules usually shrivel and fall before they are ripe. Occasionally a capsule will mature and yield ripe viable seeds but thus far the greatest number of seeds obtained from a single capsule is 5 (Stout, 1926). The total number of seeds which a mature capsule of the size typical of the Europa clon should be able to yield is perhaps at least 25. As many as 40 seeds have been obtained from a single capsule of other species. It would seem that in the case of the Europa clon only a few ovules of an ovary are able to function and that even with compatible fertilization these do not usually furnish sufficient stimulation to insure development and to check the ready and early abscission of ovaries characteristic of this clon. The inability to produce more than a very few seeds in a capsule is evidence that the proportion of functional ovules is about the same as the proportion of functional pollen grains.

SUMMARY AND DISCUSSION

Summary of the Chromosome and Nuclear Behavior in the Europa Clon

The abnormalities that develop during somatic mitosis and during meiosis in plants of the Europa clon are of three main classes:—(1) increase in the number of the chromatin units, (2) unequal and irregular distribution (non-disjunction and non-distribution) of the chromatin units and (3) irregularities in the organization of the nuclei concerned in the processes of meiosis and resulting from them. Due to the abnormalities that develop during sporogenesis, the abortion of spores is almost complete.

In the somatic cells of the root tips a nuclear organization of 12 chromosomes is maintained in the majority of the cells. But non-distribution of chromosomes frequently occurs giving in the anaphases groups of 11 and 13, or of 10 and 14. A non-distribution as great as 19 and 5 (Pl. I, Fig. 3) has been observed. Thus certain nuclei in the root tips receive more than the normal number of 12 chromosomes through non-distribution, and not merely by fragmentation as reported by Hance (1918) for *Oenothera scintillans*. When the number of chromatin units rises to 26 and 30 (Pl. I, Fig. 5) the increase may be brought about by non-distribution, or by fragmentation, or by a combination of both.

When there are such high numbers, some of the units appear to be somewhat shorter than is usual (compare Pl. I, Figs. 2 and 3 with 4 and 5), but this is the only evidence which suggests that segmentation has occurred in somatic divisions. There is definite evidence that the number of entire chromosomes may increase to at least 19 by non-distribution. It seems reasonable to consider that the numbers can increase further by non-distribution to as many as 30, which is the highest number thus far observed in a daughter nucleus in a somatic division (Pl. I, Fig. 5).

No evidence has been found of a completely arrested somatic division in which two sets of daughter chromosomes combine in one nucleus to give a double number, as described by Nemec (1903, 1904) for the somatic cells of root tips treated with solutions of chloral hydrate. In the root tips of the Europa clon the increases in the number of chromosomes arise primarily in non-distribution during the course of the formation of two nuclei.

Thus far no direct and convincing evidence has been obtained which shows that in plants of the Europa clon any of the pollen mother cells receive more than 12 chromosomes. But following an apparently normal synapsis, irregularities in the size, shape and number of chromatin masses are very frequent. Part of this is due to non-pairing, in which varying numbers of univalents are present with the limit of 12 when the chromosomes are all intact and are in normal number. But the number of chromatin units rises above 12 by (1) the failure of chromosomes to develop fully during the early stages of diakenesis or preceding these stages, (2) by fragmentation during diakenesis and in the prophases and the metaphases of the first mitosis, (3) by the omission of pairing and by the splitting of chromosomes in the first meiotic division until, in the extreme, this division becomes the same as a somatic mitosis and (4) by a second splitting in the second division. Thus the normal number of 24 chromosomes for the completed second meiotic division may be increased to at least 60, although in the cases of the highest numbers (Pl. II, Figs. 24 and 30) some of the units may represent fragments of chromosomes.

The number of chromosomes or of chromatin units which nuclei receive in sporogenesis depends in part on variations in the division and multiplication of chromosomes but also on irregularities in their distribution and in the number of nuclei that are formed.

The distribution of the chromatin units is frequently unequal and erratic in both the first and the second divisions of meiosis involving non-disjunction and non-distribution, both when there is the normal number of chromosomes and when the number is abnormal. The formation of central spindle fibres, of cell plates and of nuclei may also be abnormal in various respects. From one to as many as nine spores may be formed from one pollen mother cell, always, however, with the presence of the phragmaplasts. The number of chromatin elements that enter the microspores varies greatly. Finally, many of the pollen grains are undersized and the poorly developed micro pollen grains regularly contain subnormal numbers of chromosomes. The percentage of viability in germination tests is always low. Tests by cross-pollination indicate that only a small proportion of the ovules are able to function in the fertilizations that give rise to embryos. There is a very decided abortion of both microspores and macrospores that is persistent and very uniform for all plants of this widely cultivated clon.

THE CHROMOSOME NUMBER FOR THE EUROPA CLON

Statements as to the number of chromosomes present in the cells of plants of the Europa clon have been made by several investigators. In his paper of 1882 (p. 496) Strasburger states "Die Zahl der Doppelelemente in der Kernplatte ist annähernd 12." Evidently this statement refers to the number of paired chromosomes and according to this the somatic or diploid number would be 24. But one of his figures (his Fig. 62) shows only 6 chromatin masses that are evidently bivalents in the equatorial plate of the first meiotic division. Another figure (his Fig. 61) shows 10 masses in diakinesis, which we may now perhaps interpret as including 2 bivalents and 8 univalents. He evidently saw cases where the 12 univalents were all dividing in the first division and considered that this was evidence that the number of paired chromosomes in the reduction divisions is 12. In the material of *H. fulva* studied for his later paper (1900) Strasburger evidently observed many irregularities in the number of chromatin units, which he seems to attribute largely to poor fixation. Thus in his Fig. 65, which is an equatorial plate of the second division, there are 13 masses which appear to be in the early stages of fragmentation. In his Fig. 66, which is one of the groups of the anaphase of the second division, there are 10 split chromosomes, of which several are X-shaped.

Juel (1897) makes no definite statement regarding the number of chromosomes present in plants of *H. fulva*. But his figures reveal various numbers. In the early stages of the first division (his Fig. 2) he shows as many as 10 masses, and in the metaphase and anaphase of this division he presents (his Fig. 6) as many as a total of 24, quite as shown in our Pl. II, Fig. 17. Juel's Fig. 14 is of one of the two plates of the second division and this one indicates 18 X-shaped or double chromosomes, quite as in one of the groups in our Pl. II, Fig. 25. Juel says in the explanation of this figure that the number of chromosomes is at least 18.

The normal number of 6 bivalents or of bivalents and univalents to the total of 12 univalents seems to be approximated in various of the figures drawn by Strasburger and by Juel, but in other of their figures numbers higher than the normal are to be noted, quite as they are found in our material.

Recently Belling (1925) published a drawing (his Fig. 10) of the metaphase of the first division with 11 chromatin masses, many of which are split and all of which are evidently in stages of fragmentation. He also shows in a late anaphase of a first division or possibly in the prophase of the second division, two groups of 18 and 15 split or X-shaped chromosomes quite similar to the cases which we show in Pl. II, Fig. 25. Belling concludes that a plant of *H. fulva* is a triploid with 33 chromosomes in the somatic cells, but he notes that it must be an irregular triploid with varying numbers of trivalents, bivalents and univalents in the first metaphase. His study did not involve examination of the somatic cells.

Tischler (1927) records the haploid number of chromosomes for plants of *H. fulva* as 16 and cites as the authority a not yet published manuscript from S. Nawaschin.

Schürhoff (1926, p. 461) reviews various of these conflicting statements regarding the chromosome number in *H. fulva* and concludes with the statement "Ich prüfte daher die Chromosomenzahl nach und fand 24 als haploide Chromosomenzahl."

Timm (1928) reports that the haploid number of chromosomes in pollen mother cells of certain plants of *H. fulva* is 12 and he shows (his Abb. 2) an equatorial plate of the first reduction division with 12 chromatin masses, which he considers to be bivalents. He does not report studies of the somatic cells of *H. fulva,* but he states that cells in the root tips of *H. citrina* possess 24 chromosomes. This we do not confirm. Four different strains of *H. citrina* are being grown at The New York Botanical Garden. Sections of the root tips of two of these strains have been studied and in all cases the sections show 12 chromosomes. Since the publication of the paper by Timm the prepared slides of these root tips were carefully re-examined * and the count of 12 fully verified.

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* This study was made by Miss Clyde Chandler, technical assistant of The New York Botanical Garden.

Thus the numbers reported for the diploid or somatic number of chromosomes in plants of the Europa clon are 24 (Strasburger, 1882; Timm, 1928), 32 (S. Nawaschin per Tischler, 1926), 33 (Belling, 1925), and 48 (Schürhoff, 1926). All of these estimates are based on studies of stages in sporogenesis in which, we find, there is frequent multiplication of chromosomes and of chromatin units, giving numbers much higher than the normal number of 12 present in somatic cells.

In discussing the reports of different chromosome numbers for *H. fulva*, Timm suggests that there are different races. It is, however, to be noted that all of the different numbers reported may be found in a single plant and even in a single anther. Our studies involve plants of the Europa clon obtained from Italy, France, Belgium, Holland, Sweden, England and various parts of the United States. All these plants are indistinguishable; all have normally 12 chromosomes in the cells of root tips; all have the same types, ranges and degrees of irregularities in sporogenesis. We find, hence, no evidence that there are different races in this particular group of plants.

It is now fully obvious that the irregular numbers of chromatin units that develop during sporagenesis in plants of the Europa clon make it necessary that a decision as to the number of diploid chromosomes in the tissues of the plant be based on studies of somatic divisions as well as of the early stages of meiotic division. But here also irregular chromosome numbers may occur as our figures show. Possibly this is true of numerous other plants now classed as polyploids.

Increase in the Number of Chromatin Units

A feature of special interest in the abnormalities of sporogenesis in plants of the Europa clon is the frequent increase in the number of chromatin units both by irregular segmentation and by splitting. Segmentation is seen in diakinesis and in the prophases and metaphases of the first meiosis. In extreme cases it may involve all the chromosomes.

The splitting of univalents during the first meiotic division, such as is seen in the Europa clon, has been observed in various plants. In fact, this behavior seems to be frequent in many hybrids and in many cases of polyploidy. It appears, however, to be the rule that the splitting which occurs in the first division is not followed by another splitting and that the total number of chromosomes is, hence, not raised above that which is normal for the total of the second division. Yet in these cases unequal distribution of the units may give greater or less numbers than the normal haploid number to certain of the spores and gametes.

Two splittings of single chromosomes during meiosis, such as are seen in Europa are apparently not frequent among plants. Such behavior has been reported especially for certain *Hieracium* hybrids by Rosenberg (1917) and for certain canina roses by Tackholm (1922). Karpechenko (1927 *a* and *b*) also reports a splitting of some of the univalents in the first division as well as in the second division, but he states that this very seldom occurs in his material. Karpechenko's studies are of special interest as reporting definitely the development of functional gametes with the somatic number of chromosomes or with higher numbers. In his F_1 hybrids between *Raphanus sativus* x *Brassica oleracea* the somatic number is 18 with 9 derived from each parent. Most frequently the number of chromosomes in gametes is 9 but these abort or are nonfunctional. Only a few spores are functional and these have 18 or more chromosomes—the numbers 18 and 36 being most frequent. The number 18 arises by the complete omission of a reduction division, followed by the organization of all the chromosomes into one nucleus, which divides in the second division of sporogenesis simply as a somatic division, giving two spores with 18 chromosomes each or in case of non-distribution with such numbers as 16 and 20.

Karpechenko also reports that pollen mother cells may contain two nuclei, whose chromosomes collect in one spindle, divide as in somatic divisions and give rise to two pollen grains with 36 chromosomes in each. This seems to suggest that the chromosome groups from the male and female parents of these hybrids have maintained group identity and not mingled as they usually do. One of Karpechenko's figures (his Fig. 17, 1927a) shows more than 70 chromosomes, a condition which he considered to be due to a "two-fold splitting of some univalents" or a splitting in the first as well as in the second division of meiosis. By such means the number of chromosomes is multiplied in certain cases to at least twice the somatic number. These extra splittings parallel those we have observed but we have seen no indication that two nuclei are present in the pollen mother cells of plants of the Europa clon.

Piech and Moldenhawer (1927), also working with hybrids between *Raphanus sativus* and *Brassica oleracea* but evidently with different strains, find an increase in the number of chromosomes during the first meiosis from 18 to as many as 36 by the splitting of univalents. They report no further splitting and they state that in the second division four spores are formed and that the number of chromosomes is thus reduced to 9. The second division is hence a reduction division. But irregular distribution or the formation of fewer than four spores may give more than nine chromosomes to certain spores. Here evidently there is less irregularity than in Karpechenko's material.

In most studies of irregularities in sporogenesis attention has been directed chiefly to the irregular distribution that accompanies the presence of unpaired chromosomes. A double splitting with partial or incomplete separation such as is seen in the Europa clon may be more general than is now apparent.

TYPES OF STERILITY INVOLVING ABORTION OF SPORES

It is to be recognized that there are several types of germ-cell abortion in flowering plants, especially in respect to that condition or status of the plant which may, perhaps, be regarded as an underlying or fundamental cause of the sterility. On this basis the following classes of sterility due to spore abortion may be recognized:—

1. Abortion of sporophylls, of spores and of sex cells is a characteristic feature of *intersexualism*. In extreme cases of male sterility in intersexes the stamens are merely rudimentary organs, as in *Plantago lanceolata* (Stout, 1919). In certain other pollen-sterile plants, such as the Brighton grape (Dorsey, 1914), the abortion occurs after the formation of pollen grains by a degeneration of the generative cell or of the divisions that produce that cell. In such extreme cases of cyclic alternations in sex as are seen in *Cleome spinosa* (Stout, 1923) there is an alternating graded series of abortions in the development of the flowers throughout the flowering period. At one time the pistils are aborted and at another time the stamens are aborted, and in the climax the abortion of sporophylls reduces them to merely rudimentary structures. The distinguishing feature in the intersexes is that the abortion is typically merely one-sided. There is an abortion of one sex while the other may be fully functional. In intersexes the abortion is obviously not due fundamentally to misfits in the relations of chromatin material or to the erratic behavior of chromosomes but to a loss of maleness or of femaleness through some fundamental systemic regulation that is regularly hereditary. Both as to expression and cause it is distinct from various other types of sterility which involve abortion of sex organs.

It is clear that the abortion of spores as developed in the Europa clon is not that of intersexes, for it obviously affects both microspores and macrospores to the same degree and at the same time.

2. Cytological studies of the pollen sterility of hybrids have been numerous since such earlier studies as those of Juel (1900) for *Syringa*

vulgaris, of Tischler (1906) for the hybrid *Ribes Gordonianum* (recently reinvestigated by Tischler, 1927) and of Rosenberg (1909) for *Drosera obovata*. Hybrids are frequently more or less sterile from abortion of spores and sex cells and this involves a rather wide range of nuclear and chromosome irregularities not only when the two sets of parental chromosomes are unequal in number but also when the numbers are equal.

There seems to be rather general agreement that in the sterility of hybridity the irregularities occur during meiosis, particularly in the non-pairing of univalents and in their subsequent irregular distribution. It is characteristic of the sterility of hybridity that the abortion develops to the same degree in the formation of both the microspores and the macrospores, which indicates that the abortion involves fundamentally incompatible relations between chromosomes.

In a recent paper Blaringhem (1928) considers that the Europa Daylily arose as a hybrid. This view is based in part on the high degree to which abortion of spores occurs and in part on the results of his breeding experiments. In using pollen of Europa in crossing with *H. flava* he obtained plants of the first generation and also he grew a second generation, but all were yellow-flowered, as is *H. flava*. There was in their flowers no trace of the fulvous-red coloring characteristic of *H. fulva*. In further use of the pollen of Europa on flowers of *H. flava* and *H. auranteaca*, out of a considerable progeny only two had fulvous-red coloring in the flowers. Evidently these two plants were the only ones that were hybrids. These differed in vigor of growth and in sterility and because of this it was assumed by Blaringhem that the Europa parent is itself a hybrid.

In the breeding of day lilies at The New York Botanical Garden plants of *H. flava* have been highly self-compatible and also frequently self-pollinating before flowers open. But where flowers are emasculated in the bud before pollen is shed, the properly guarded pollinations with pollen of the Europa clon give in every case F_1 hybrids that possess considerable fulvous red in the coloring of the flowers. This is likewise the case for the reciprocal hybrids. In the next generation obtained by crossing F_1 plants or of back-crossing with Europa there has been great variation in vigor of growth and in the degree to which fulvous coloring is developed. This may mean that Europa is itself heterozygous or that the inheritance of its fulvous coloring is on the basis of multiple factors. The species to which the Europa clon belongs is a variable one, judged by the wild plants obtained from China and Japan.

Self-incompatibility is so strongly developed in the species that at least many plants of seedling origin are the result of cross-pollination between plants that differ in coloration. The Europa clon is evidently heterozygous for color of flowers, but there is no very conclusive evidence that it is a hybrid between two distinct species. Among the wild plants obtained from China and grown at The N. Y. Botanical Garden there have been some that very closely resemble the Europa clon, especially in respect to the color and shape of the flowers.

The abnormalities seen during sporogenesis in plants of the Europa clon closely resemble those common in hybrids, especially in the nonpairing, the nondisjuction, the irregular distribution of the chromosomes and the formation of extra numbers of pollen grains. The omission of the reduction division and the multiplication of chromosomes during the divisions are also quite similar to irregularities observed in certain known hybrids.

3. A rather extensive literature has recently appeared concerning the sterility of polyploids. It appears that the odd numbers of chromosomes in triploids, pentaploids and various aneuploids promote irregularities in meiosis which result in the abortion of spores. (See especially Blakeslee and Cartledge, 1927.) But here, as in certain hybrids, abortion may also develop in forms having sets of chromosomes of even number, which, however, seem to be "unbalanced" in the relations of meiosis.

Sterility in polyploids is undoubtedly a chromosome phenomenon coming to expression during meiosis. As a general rule, it develops in quite the same degree for both microspores and macrospores and hence is quite similar to sterility from hybridity. In certain cases, as in *Fragaria* (Longley, 1927), dioecious plants are found to be polyploid, but, as in such cases the chromosomal complex of a plant is fully potent in one sex, it would seem that such one-sided abortion is not merely due to the number of chromosomes involved.

Plants of the Europa clon are clearly not polyploid. In the somatic tissues the normal number of chromosomes is 12, which, it now appears, is the basic diploid number for the genus. In the chromosome irregularities there is an increase in the number of chromatin units, so that many of the cells become polyploid and aneuploid, and in this respect the abortion of spores may be similar to that which occurs in plants whose somatic cells are uniformly polyploid.

4. Abortion of spores is the rule for plants which produce seeds by parthenogenesis or by apogamy. The cytological studies of such plants

show very marked irregularities throughout the processes of sporogenesis. In reviewing these Sharp (1926, p. 356) has noted that there is "a series of transitional conditions between normal meiosis associated with sexuality and failure of meiosis associated with apomixis." It seems that a rather common rule of behavior in apogamic plants is that the egg mother cells merely continue in somatic divisions with slight signs, or even no signs at all, of the stages of synapsis and meiosis, while for the pollen mother cells there are such irregularities that the pollen is usually all aborted. Examples of this are the common dandelion (Jeffrey, 1927), and the hawkweeds, which have been studied by Rosenberg (1917, 1927).

In respect to many of the irregularities in sporogenesis, there is much similarity between the conditions found in hybrids, polyploids and parthenogentic forms. In the latter, however, there is the ability to produce embryos vegetatively. Parthenogenetic and apogamic forms include both hybrids and polyploids, and the evidence of relationship is so strong that it has been considered by some (Ernst, 1918; Jeffrey, 1927) that hybridization and polyploidy of themselves frequently stimulate parthenogenetic tendencies in the ovule apparatus.

There is no evidence that plants of the Europa clon are in the least degree parthenogenetic or apogamic. The few seedlings that have thus far been obtained from them are the result of cross-pollination with other species and are obviously all hybrids.

5. In the four classes of plants mentioned above which exhibit irregularities in meiosis and abortion of spores, the fundamental condition responsible for the irregularities may be considered as inherent in the plants themselves or as inherent in some condition or set of interrelations between the mechanisms of the cells and particularly of the germ cells. A somewhat similar irregular behavior of chromosomes both in mitosis and in meiosis has in various cases been induced by subjecting plants to chemical influence (to chloral hydrate, Nemec, 1904), to mechanical treatment such as shaking, and to higher and lower temperatures than usual, all of which temporarily modify the physiological condition of the cells concerned in sporogenesis.

In considering the causes of pollen abortion in *Hemerocallis,* Timm (1928) emphasizes the possibility of the action of climatic influences. But it can scarcely be considered that a purely external influence, such as temperature, plays an important role in producing the high percentage of gametic sterility always and very constantly seen in plants of the Europa clon, as they grow rather widely in the North Temperate Zone.

At any rate, certain plants of the same species, plants of other species and certain seedlings of Europa parentage show little or no abortion of spores when grown under the same conditions.

6. The doctrines of plethoric sterility and of correlative sterility have frequently been evoked to explain cases of sterility of plants that propagate vegetatively. It has been claimed that there is a direct competition for food material between vegetative organs of reproduction and the organs concerned with seed reproduction, and also that the degeneration of sex organs may result from long-continued propagation by sexual means.

There is no conclusive evidence that any clon of plants such as Europa has changed from a condition of high sexual potency to a condition involving the degeneration of the sex cells because of extended vegetative propagation. The evidence indicates that the original seedling from which such a clon has been derived was itself as strongly pollen-sterile and egg-sterile as are the plants now grown of the clon. This, however, does not necessarily indicate that a correlative or a plethoric sterility may not be operating in the Europa clon, but only that, if it is operating, it was inherent in the nature of the original seedling.

Various individuals belonging to the same species as this Europa clon and also various seedlings having it as a parent are highly potent as seed and pollen parents. Also many individuals of various related species show little or no abortion of spores. The habit of vigorous vegetative reproduction, which is well developed in the genus, does not of itself necessarily induce abortion of spores and loss of sexuality.

The Inherent and Hereditary Nature of Spore Abortion

For various types of sterility it is frequently the rule that there is an abortion of a rather definite proportion of the spores. In some cases the very constant proportions of spore abortion in plants and in their offspring have been interpreted in terms of hereditary factors conceived to be directly concerned with sterility (see especially Belling, 1914; Shull, 1927). With such a viewpoint the rather definite relation of about twenty aborted spores to one viable spore for sporogenesis in plants of the Europa clon may suggest the presence of multiple factors operating in the development of the haploid generation. At any rate, the rather definite degrees of abortion seen in various types of sterility indicate that there is some condition inherent in the plant that determines and regulates the percentage of abortion.

In hybridity the abortion is assumed to be determined by the interrelations of the chromosomes. In apogamy the abortion is obviously due to a very different condition or at least a further development, for there is loss of sexuality with the substitution of vegetative methods of seed formation, which maintains the nuclear organization of the somatic cells. In intersexes the chromosomal complex is of itself in no way directly responsible for the abortion that operates in only one of the two kinds of sex organs (pistils or stamens).

The Immediate Causes of Spore Abortion

A study of the fundamental nature of the cell processes involved in the destructive activities of spore abortion shows that they fall into a few simple categories whose essential characteristics and etiological relations can be viewed in the light of the known facts of cell growth and reproduction.

Spore abortion is largely predetermined by the events of fertilization. In fertilization there is the fusion of two nuclei, which may possess and very often do possess cytoplasm and germ plasm of very different hereditary and physiological properties. Also polyploidy, arising within a strain, may produce gametes that are quite different in quantitative as well as qualitative properties. That the interactions in fertilization may be destructive is well shown in embryo abortion. In some cases such abortion is so definite that the theory of balanced lethals may be applied. As Davis (1915, 1923) has pointed out, there may be a high degree of abortion of zygotes or embryos in hybrids and in such plants as certain of the Oenotheras, which are also somewhat characterized by irregularities in sporogenesis. Much embryo abortion is no doubt due to a decided lack of harmony in the interactions between protoplasmic units that become associated in the same nucleus through fusion. Fertilization is a critical point in ontogeny. It initiates an association of different elements of protoplasm that prevails and interacts throughout somatic divisions and culminates in the more complicated relations in sporogenesis.

Certain grades or degrees of differences in gametes will yield nuclear organizations in fertilization that apparently live more or less in harmony until sporogenesis is reached, when the abortion of spores becomes a conspicuous feature. The abortion is associated with the more intimate pairing of chromatin units in synapsis and with the return to the haploid generation. It is characterized by irregularities in chromosome behavior.

Sporogenesis is also a critical stage in ontogeny. It is equally critical, or perhaps more critical, than fertilization.

Irregularities in chromosome behavior are to be found, however, in the cell divisions of somatic tissues. In the root tips of the Europa clon abnormal chromosome numbers readily develop through non-distribution. Furthermore, we find no evidence that somatic nuclei which receive a low number of chromosomes or a number less than 12 can continue in division. For such cells there is cessation of division, which amounts to a tissue abortion. Such irregularities are without a doubt due to the expressions of the same sort of incompatibilities with which we are more familiar in the forms of sterility in reproductive organs. The behavior of chromosomes in the somatic cells of hybrids and of polyploids has been too little studied; it may be much more erratic than is now supposed.

The irregularities and abortions which appear in mitosis and in meiosis indicate that the destructive interactions develop especially when (a) chromosomes are in relations with kinoplasm, (b) when chromosomes are in processes of splitting or fragmenting and (c) when the activities of pairing and disjunction of chromatin units are in progress. The relations of kinoplasmic activities to chromosomes are important aspects of chromosome behavior in nuclear divisions. In somatic divisions the kinoplasmic activities complete nuclear division where non-distribution is very pronounced (Pl. I, Figs. 3, 4 and 5) and this may continue for certain cells that have received increased numbers of chromosomes. In sporogenesis kinoplasmic activities become very irregular. With the lagging of chromosomes in the first meiotic division micronuclei form, and many, or perhaps all of these, do not divide further. Cell plates form after the first division with the greatest of irregularity and, when there is much fragmentation and multiplication of chromosomes, there is delayed action of kinoplasmic structures.

The meiotic divisions are obviously more complicated than are somatic divisions both in the activities of chromatin and in the rôle of kinoplasm. Synapsis and the relations that follow between chromosomes bring chromatin elements into more intimate interactions than previously existed. Disjunctions and nondisjunctions bring new relations in nuclear organizations more varied or at least more intense than those of somatic divisions. It seems clear that it is the interactions between chromosomes or between parts of them that give rise to the degenerations in cell processes and to the abortion and death of cells. The abnormalities suggest the poisonous or toxic actions of foreign proteins in colloidal relations.

In the somatic and the pollen mother cells of plants of the Europa clon there is normally a numerical equality in the two sets of chromosomes and there are no noticeable differences in the size and the shape of the chromosomes. The incompatible relations develop as inherent qualities of chromosomes that are balanced as to number. Yet there are fragmentations of chromosomes, failure of pairing, non-distribution, non-disjunction, division of univalents both in the first and in the second meiotic divisions, the formation of abnormal shapes in chromatin units, and the irregular formation of spores as to size, number and chromosome complement. Finally there is abortion, death or a non-functioning for nearly all of the sporogenous tissue. The fact that few functional microspores and macrospores are formed is, perhaps, an indication that only in a few cases do the chromosomes find themselves in mutually harmonious relationships as to number, form, complement, chemical and physical interactions, and perhaps relative position similar to those which existed in the gametes which united to make the individual plant from which the clon has been propagated asexually.

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PLATE I

The drawings for these figures were made mostly at magnifications of from 1800 to 2400. The reproduction here given is about two-thirds the size of the originals. All figures are of the *Hemerocallis fulva* clon Europa:—

FIG. 1.—Equatorial plate of somatic division showing the normal number of 12 chromosomes.

FIG. 2.—Anaphase of mitosis showing 12 daughter chromosomes passing to each pole.

FIG. 3.—Anaphase of mitosis with much non-distribution. Only 5 chromosomes are at one of the poles.

FIG. 4.—Anaphase of mitosis with at least a total of 40 chromosomes.

FIG. 5.—Anaphase of mitosis with a total of 56 chromosomes passing to poles in groups of 26 and 30.

FIG. 6.—A typical synapsis in pollen mother cells.

FIG. 7.—Diakinesis with 4 bivalents and 4 univalents.

FIG. 8.—Diakinesis with large and small chromatin masses, the total number being at least 17.

FIG. 9.—Diakinesis with at least 24 masses of chromatin of irregular sizes, some of small size.

FIG. 10.—Late diakinesis with 6 bivalents. The number of chromosomes is normal and all are in pairs.

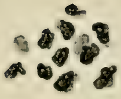
FIG 11.—Polar view of equatorial plate of the first division of reduction showing 6 bivalents, or 12 chromosomes, arranged in 6 pairs, a condition fully normal.

FIG. 12.—Equatorial plate of first division with 6 bivalents all of which are in the early stages of segmentation and fragmentation.

FIG. 13.—Equatorial plate of first division of meiosis showing 5 bivalents and 2 univalents, and Fig. 14, a sister nucleus in same stage and at same magnification, showing 12 univalents all in process of dividing.

FIG. 15.—Equatorial plate of first division with 6 bivalents showing considerable fragmentation.

FIG. 16.—Equatorial plate of first division with much fragmentation.



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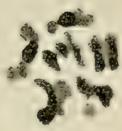

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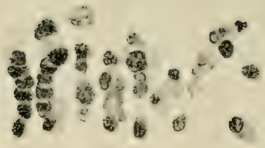

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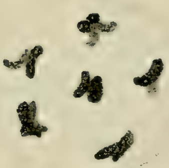

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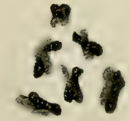

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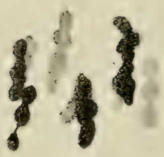

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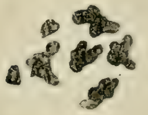

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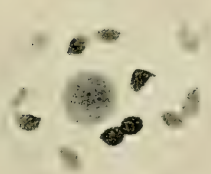

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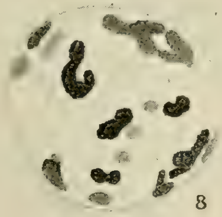

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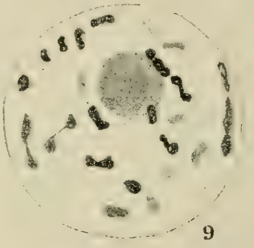

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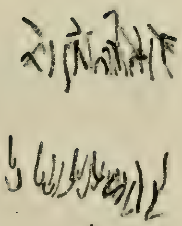

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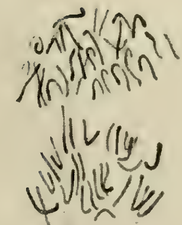

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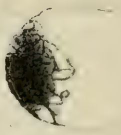

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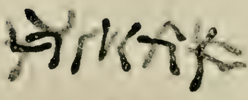

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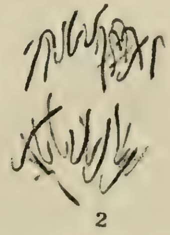

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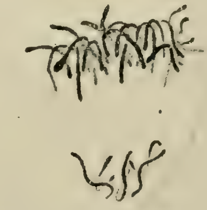

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PLATE II

The drawings for these figures were made mostly at magnifications of from 1800 to 2400. The reproduction here given is about two-thirds the size of the originals. All figures are of the *Hemerocallis fulva* clon Europa:—

Fig. 17.—Metaphase of the first division showing 12 chromatin masses passing to each pole, with some split and some fragmenting.

Fig. 18.—Splitting and fragmenting of chromatin masses in the metaphase of the first division.

Figs. 19 & 20.—Early anaphase of first division with a lagging chromosome.

Fig. 21.—Three groups of 4 chromosomes with some split, at the time of the anaphase of the first division.

Fig. 22.—Anaphase of the first division with cell plate forming and parts of one chromosome on opposite sides of it.

Fig. 23.—Anaphase of first division with the 6 chromosomes of each group split for the second division.

Fig. 24.—A condition after the equatorial plate stage of the first division. The chromosomes have fragmented and split and some are of irregular shape. The distribution is irregular. This condition follows that shown in Fig. 16.

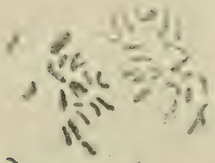
Fig. 25.—A condition frequently seen following the anaphase of the first division with X-shaped chromatin masses developed.

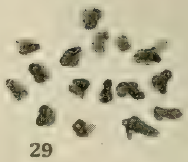
Fig. 26.—One of two cells formed by the first division. The 6 chromosomes are split for the second division.

Fig. 27.—Two cells formed by the first division, one with 6 chromatin masses, the other with 12, some of which are split.

Figs. 28 & 29.—Polar views of the two equatorial plates of a second division in reduction, one with 12 masses, the other with 16, and all in process of dividing.

Fig. 30.—An anaphase of the second division with four groups of chromatin masses of the numbers 12, 16, 17, and 18, with some of irregular shape and possibly double.





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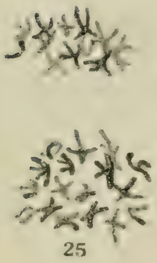

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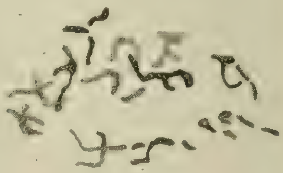

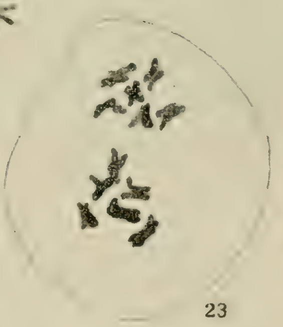

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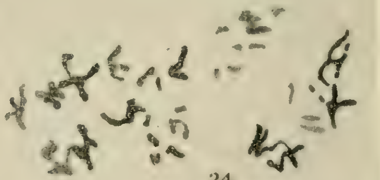

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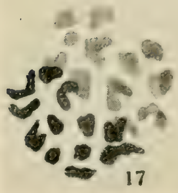

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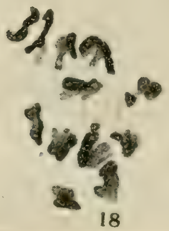

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PLATE III

The drawings for these figures were made mostly at magnifications of from 1800 to 2400. The reproduction here given is about three-quarters the size of the originals. All figures are of the *Hemerocallis fulva* clon Europa :—

FIG. 31.—Anaphase of the second division. The chromosomes are nearly normal in shape and in total number, but they are being distributed into five groups of 3, 4, 6, 6, and 7.

FIG. 32.—Anaphase of the second division. The total number of chromosomes is normal, their shape is normal, the number of nuclei being formed is normal, but there is non-distribution in each of the two spindles.

FIG. 33.—Five nuclei developed from one spore mother cell. They are of different sizes and contain X-shaped chromatin masses. Chromatin material is stretched between two of the nuclei.

FIG. 34.—A normal number of 4 nuclei following the second division.

FIG. 35.—Four cells of a quartet somewhat unequal in size and the nuclei containing X-shaped chromatin masses (magnified only 1000 X).

FIG. 36.—Microspore at the time of the division of its primary cell. There is the normal haploid number of 6 chromosomes. Below, the equatorial plate much more enlarged.

FIG. 37.—The same stage shown in Fig. 35 but the number of chromosomes is 18.

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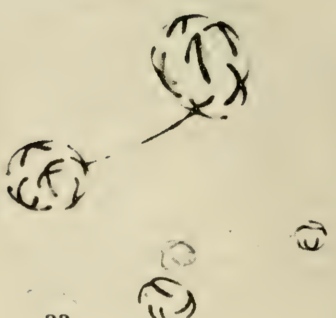

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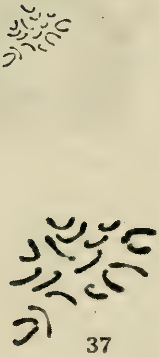

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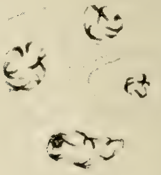

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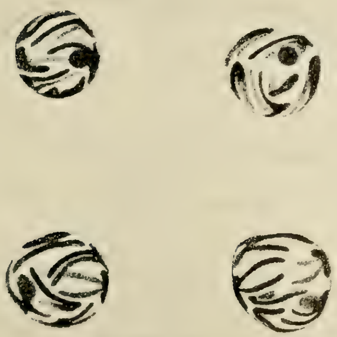

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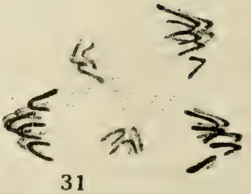

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THE NEW YORK BOTANICAL GARDEN

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ACCESSIONS

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INSECTS

Last summer's dry weather, while checking some of the fungous diseases, may have lowered the resistance of plants to a degree where certain insects became an unusual menace.

Aphid

Both Japanese and German Iris have been hosts to the aphid *Anuraphis Tulipae* Boyer during the past season and have required treatment with Black-Leaf-40 and soap. This sucking insect feeds on the upper parts of leaves as well as on the base near the growing point, often below the soil surface.

Verbena Bud-Moth

In August two insects destructive to the seeds of valuable crosses were reported at work in the Iris garden. One of these, the Verbena bud-moth, *Olethreutes hebesana* Walker, was first noted in its pupal stage. The brown pupa case projects from a black-ringed hole in the seed pod, where the larvae have been feeding for about three weeks. Three days after emergence of the adult, the eggs are desposited on the pod surface. The hatched larvae enter the pod and feed on the seeds until ready to pupate. As there are at least four generations during the season, several applications of an insecticide such as arsenate of lead should be made, beginning soon after the pods begin to form. The insect overwinters as larvae or pupae in cocoons on the leaves or within seeds.[6] It has been widely reported not only as a pest of Iris, but as a " general feeder " on plants.

Weevil

The other insect observed attacking Iris seeds was identified by Dr. K. F. Chamberlain, assistant state entomologist, as the weevil *Mononychus vulpeculus.* This insect tunnels through the seeds, eating out the embryo and leaving of each seed only a thin ring. At the end of a tunnel which sometimes extends through a whole row of seeds, the small dark weevil may be found with its flat disk-shaped body fitting snugly into the last seed it has mutilated. This pest has been commonly found in the seed pods of native Blue Flag, according to Dr. Chamberlain, but its occurrence on cultivated Iris is somewhat rare. It was reported in 1921 from Connecticut[7] as eating the petals and breeding in the seed pods of Japanese Iris, and in 1926 in Iris pods on Staten Island.[8] Its presence in Bronx Park, though not in connection with Iris, has also been reported.[8] The limited extent of its injury to cultivated plants has not warranted a study of control methods, but, as the adult weevils are flying as early as May, applications of an arsenate of lead spray early in the season should kill the insect before its eggs are laid and the larvae bore into the pod.

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[6] Ries, Donald T. Two Iris Insects. Bull. Am. Iris Soc., **32**: 27–47. Jl 1929.

Citrus Scale on Iris Plants

An interesting infestation—the Florida red-scale (*Chrysomphalus aonidum* L.) on Iris leaves—is illustrated in FIGURE 2, C. It occurred in the propagating greenhouse, where an infested citrus seedling and some Iris plants potted for experimental purposes were in proximity. This small circular red scale is usually confined to citrus plants in greenhouses, but may live on a variety of hosts. The injury was not considered serious and the insect was allowed to develop to determine to what extent Iris plants would serve as hosts. The plants affected present a very disfigured appearance with conspicuous chlorotic spots about the insects, converging into large yellow areas. So far, several varieties are infested, but, as the pest appears to be spreading, it will be necessary to treat infested plants in order to save them.

B. O. DODGE AND MARJORIE E. SWIFT

THE NEW SPECIES HEMEROCALLIS MULTIFLORA

The latest member of the wild daylilies to be discovered and named is the species *Hemerocallis multiflora,* a description and a colored plate of which were first published in a recent number of Addisonia (**14**: *pl. 464.* Je 1929). Since the genus *Hemerocallis* is a small one, comprising at present about twelve valid species, the addition of a new species is of some botanical interest. Also the members of this genus are of value as garden plants, and the new species is to be considered in this respect. The description and the plate of *H. multiflora* already published may be supplemented by photographs and by some remarks on the possible value of this new species for use in hybridization, which aims to obtain new daylilies of merit for culture in flower gardens.

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[7] Britton, W. E. Twenty-first report of the State Entomologist for 1921. Conn. Agr. Exp. Sta. Bull. **234**: 194.

[8] A list of the insects of New York. Cornell Univ. Agr. Exp. Sta. Mem. **101**: 506. Aug. 1926.

Thus far there have been but ten plants of the species *H. multiflora* available for observation by the writer. These came to The New York Botanical Garden in 1925 as divisions of wild plants obtained at Ki-Kung-Shan, Honan, China, by Dr. A. N. Steward, then a member of the faculty of the University of Nanking. It is believed that these are the only plants of this species now in cultivation. These ten plants differ somewhat among themselves in vigor of growth and in the season of blooming. But in the characteristics of the flowers and capsules and in general habit of growth they are all very similar, and they are distinctly different from any other known species.

One outstanding character of this species is the rather large number of flowers which a scape may bear. The scapes are, as a rule, abundantly branched above and thus a single scape may produce as many as one hundred flowers during the entire season of bloom. But these flowers mature over a somewhat extended period, and so the plant has a long season of blooming and there are not many flowers open during any one day. The photograph of FIGURE 4 shows this condition; at the time when it was taken the scape had been in flower for several days and tiny buds were appearing from which flowers would open several weeks later. For a large well-established plant, there may be several scapes having from thirty to as many as one hundred flowers each, and the blooming of the entire plant may continue for a period of six to ten weeks. The specific name *multiflora* seems appropriate in regard to the total number of flowers produced by scapes.

During the four years that these ten plants of *H. multiflora* have been under observation at The New York Botanical Garden, one plant has always bloomed in July while the others have begun to bloom rather late in August, and in 1929 some continued to yield flowers until as late as November 22, which was the date of the first severe frost.

But the plants of *H. multiflora* do not have the "evergreen" habit of growth characteristic of certain other daylilies. Their

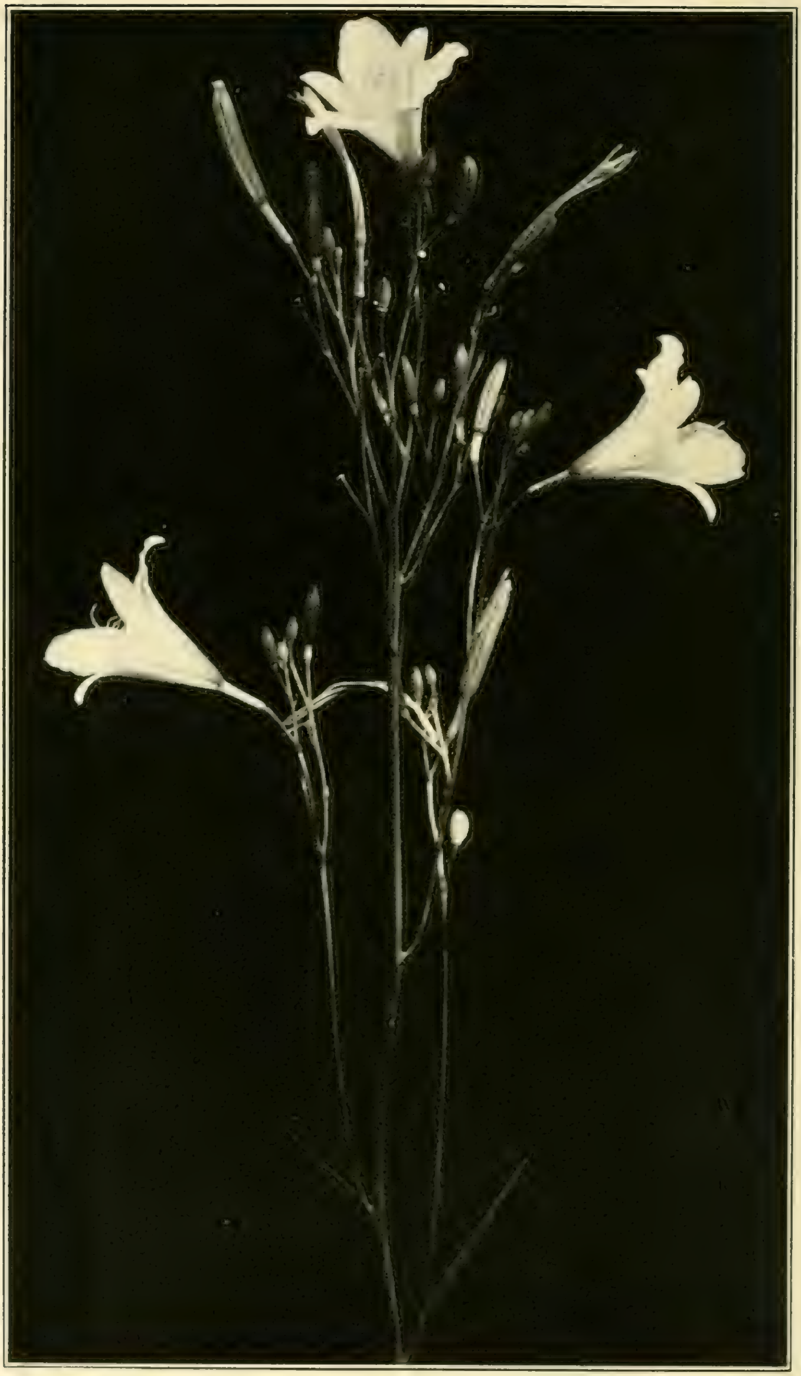

Figure 4

leaves turn brown in mid-autumn with the coming of near-freezing temperatures, after which the flowers of the late-blooming individuals continue to develop and open—a behavior unknown for any other daylily.

In the so-called " evergreen " daylilies, new leaves continue to appear throughout the summer and autumn and the plants remain with fresh green foliage until severe freezing temperatures prevail. Of the wild species now known, only *Hemerocallis aurantiaca* is decidedly evergreen. The *H. fulva* is only slightly evergreen. The foliage of the species *Hemerocallis minor, H. Dumortierii, H. Middendorffii,* and *H. Thunbergii* dies early in autumn or even in late summer. The foliage of *H. citrina* remains green until rather late in autumn and then quickly turns to a conspicuous yellow-brown and soon falls flat on the ground. But meanwhile the *H. aurantiaca* and numerous of the named horticultural clons, such as Luteola, Aureole, Ajax, Golden Bell, Sir Michael Foster, Shirley, Mikado, Vesta, Wau-Bun, etc., continue to put forth green leaves. Some of the seedlings now being grown at The New York Botanical Garden which have the evergreen habit also have a second period of blooming, or, what is more common, an occasional scape with flowers appears throughout the late summer and autumn. In this behavior there is a tendency to become " ever-blooming." But this is different from the late-blooming habit of certain plants of *H. multiflora* which have one period of flowering, which continues after the foliage is nearly dead and until cold weather arrives.

FIGURE 4. A single scape typical for the species *Hemerocallis multiflora.* Three flowers are open; several have already bloomed; numerous buds, some of small size, will continue the blooming over a period of several weeks. This particular scape was photographed on September 14 from a plant that is late-blooming.

The scapes of all the plants of *H. multiflora* are rather slender, and frequently they are gracefully bending under the load of flowers and fruit. For a few plants the scapes are somewhat stiffly erect to a height of as much as four feet; for others they are shorter and more bending. The scapes of a single plant may be rather erect at one time and decidedly bending at another time. Such variations within a wild species are not uncommon; they are often the basis for the selection of different races, or of different clons. The plants with such minor differences as are seen

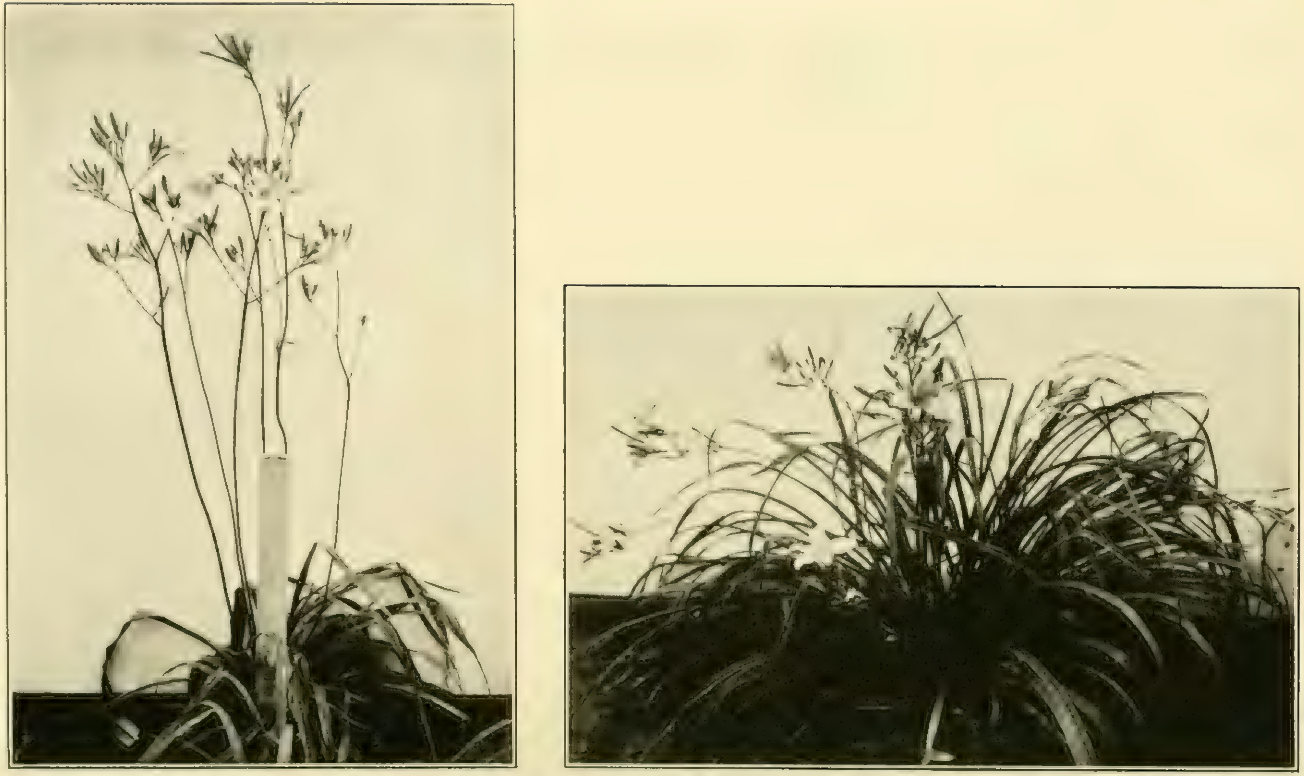

Figure 6. Showing variation in habit of growth seen among plants of *Hemerocallis multiflora*. Plant at left has scapes that are taller, more erect, and somewhat more branching. The flowers and capsules of both are almost identical.

in these plants of *H. multiflora* may be expected to give somewhat different habits of growth to the offspring from hybridization with other daylilies.

The species *H. multiflora* is itself not especially valuable as a garden plant. The flowers are of fair size and rather full with pleasing form and color, but they are scarcely large enough or sufficiently numerous on any one day to give a showy display of color in the garden.

Several plants of *Hemerocallis multiflora* have already been hybridized with other species, including some of those that bloom earliest in spring. This was accomplished by saving the pollen of the latter. Many seedlings have also been obtained in crosses with hybrids and with named horticultural clons, including some that have large flowers and some that have flowers with pink and with fulvous colors. It is the hope that the desirable characteristics of *H. multiflora,* such as long period of blooming, numerous flowers to a scape, and late blooming, will appear among the offspring in combinations that give somewhat new types of daylilies for garden culture.

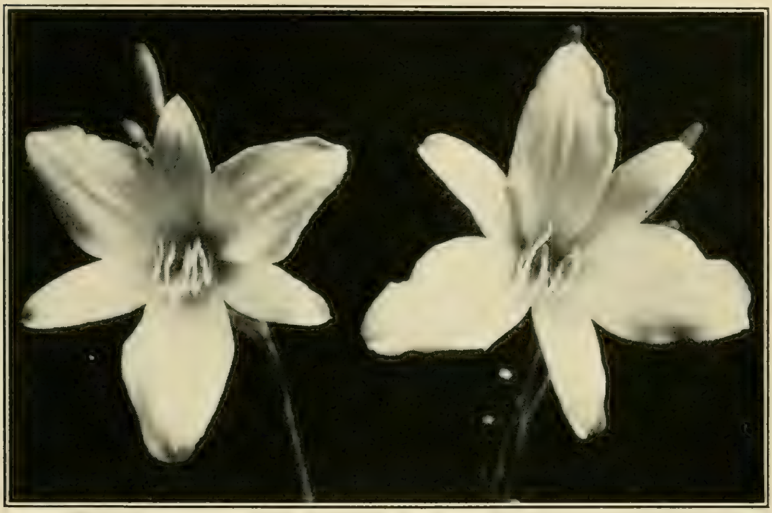

FIGURE 5. Typical flowers of *Hemerocallis multiflora,* about four-fifths natural size, showing the two extremes in orientation which flowers of daylilies may assume. The color is of a shade between chrome and cadmium-yellow—a grade of orange-yellow—and the surface is gold-glistening.

A. B. STOUT.

CHRONICLE OF EASTERN AMERICAN IRIS

The present wide-spread interest in iris and the long neglect of our native irises as botanical, not to mention horticultural, subjects make a chronicle of our eastern species timely.

The technical botanical history of Iris in North America begins with the publication of Linnaeus' Species Plantarum in 1753. However, about two centuries, dating from the early records and specimens on which Linnaeus based his North American species, comprise the total historic chronology involved. The following American Iris chronicle will be of particular interest, especially in view of the impetus recent exploration in the Gulf States has given to the study of the native plants of the genus *Iris*. The sequence of events which makes up the Iris chronicle is exceedingly unevenly distributed through the two hundred years involved.

The authors and their botanical works in which American irises figure, published prior to the appearance of the Species Plantarum, are, arranged here in chronological sequence, recorded by Linnaeus as follows:

Leonard Plukenet (1641–1706), Almagestrum, 1696.
John James Dillenius (1687–1747), Hortus Elthamensis, 1732.
Jan Fredrik Gronovius (1690–1762), Clayton's Flora Virginica, 1739.
Georg Dionysius Ehret (1708–1770), Plantae et Papiliones Rariores, 1748–'59–'62.

Late in the seventeenth century, American irises found their way to Europe, either as living plants or as herbarium specimens. A number of species from the Atlantic seaboard were recorded in the Old World literature of that period. Linnaeus (1707–1778) assembled this matter and with the aid of specimens in some cases published in his Species Plantarum, *Iris versicolor,*[1] *I. virginica,*[2] and *I. verna.*[3] *Iris virginica* L. is not be confused with the usual *Iris virginica* of the horticultural trade.

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[1] *Iris versicolor* L. Sp. Pl. 39. 1753; various provinces, eastern North America.

[2] *Iris virginica* L. Sp. Pl. 39. 1753; various provinces, southeastern United States.

[3] *Iris verna* L. Sp. Pl. 39. 1753; various provinces, southeastern United States.

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NOTES ON NEW HYBRID DAYLILIES

The project of hybridization and selective breeding with daylilies (*Hemerocallis*) has steadily progressed since a popular report of this work was published in this JOURNAL five years ago.[1] The collection of species and horticultural clons has been extended until it now includes members of all but a very few of the known daylilies. Through the assistance of various persons in China and Japan, living plants and viable seeds of wild daylilies have been obtained from several widely separated regions in the Orient. No two of these collections have been alike and in no case have the plants obtained duplicated or even closely resembled the type of the same species already in cultivation. Among the plants obtained there has been one new and distinct species which has been named *Hemerocallis multiflora*[2, 3] and also a new rose-flowered variety designated as *Hemerocallis fulva* var. *rosea*.[4, 5] These results justify the continued effort to obtain living plants and seeds of wild daylilies from as many localities as possible. There has been complete coöperation in the issuance of permits for introduction by the Plant Quarantine and Control Administration of the U. S. Dept. of Agriculture, and almost always the living plants survive shipment when they are sent in autumn or winter during their period of dormancy.

[1] New daylilies. Jour. N. Y. Bot. Gard. **26**: 169–178. Au 1925.

[2] *Hemerocallis multiflora*. Addisonia **14**: *pl. 464*. Je 1929.

[3] The new species *Hemerocallis multiflora*. Jour. N. Y. Bot. Gard. **31**: 34–39. F 1930.

[4] *Hemerocallis fulva rosea*. Addisonia **15**: *pl. 484*. Mr 1930.

[5] The fulvous daylilies—II. The wild fulvous daylilies of the Orient. Jour. N. Y. Bot. Gard. **30**: 185–194. Au 1929.

At the present time the most promising of these new wild types, all of the species as they are known in cultivation, and various of the horticultural hybrids are being used in hybridizations and in selective breeding. In certain selections, and especially those for fulvous, red, and pink flower-colorings, as many as three generations of progeny have been obtained. The seedlings already grown or now being grown total about 10,000. Several thousand of these are at Skylands, the estate of Mr. Clarence Lewis, whose support in providing space and care for growing seedlings has greatly promoted the progress of the work.

It may be said that this collection of daylilies is being very fully utilized (1) for a taxonomic study of the various species, (2) for the experimental study of sterilities, (3) for cytological studies of the conditions and processes involved in sterilities and in fertilization, (4) for determining various aspects of heredity, and (5) in selective breeding for the development of new hybrids of merit as garden plants. The conditions in this group of plants are especially favorable to this combination of interest and research.

The matter of special concern in this report is that of the selection of seedlings that are to be propagated and named as horticultural clons. A very critical judgment is being exercised in these selections and the opinions of various persons are considered in making final choice. There are hundreds of fine seedlings and if the number to choose from were small any one of many of them might well be propagated for the trade. The aim is, however, to select only those of outstanding merit, to avoid naming numerous seedlings that are almost identical, and to hold even very good seedlings for a time in the hope that still better ones of the same type or class may appear. And so each year only the very best of the seedlings are designated for special observation and for comparison. Some are used in further selective breeding. At the present time there are numerous seedlings with splendid shades of pink and sprightly red colorings that are decidedly new to horticulture and worthy of general culture. But these are being held in reserve in the thought that plants equally good in color may be obtained which have larger and fuller flowers or somewhat better habits of growth.

Brief mention may now be made of the four seedlings named.

The Cinnabar Daylily

The special charm of the Cinnabar Daylily (Figure 1) is in the rich fulvous coloring of its flowers. The plant has an excellent and semi-robust habit of growth. In New York it blooms during July, and its flowers are of good size, widely open, and numerous.

The throat of the flower is a clear cadmium-yellow; the outer half of the petals is covered, or at times somewhat streaked, with a vinaceous-rufous shade of red, and the sepals are somewhat more solidly of this color. Both the sepals and the petals are strongly gold-glistening in sunlight. The flowers are, therefore, of a rich but delicate shade of brownish red.

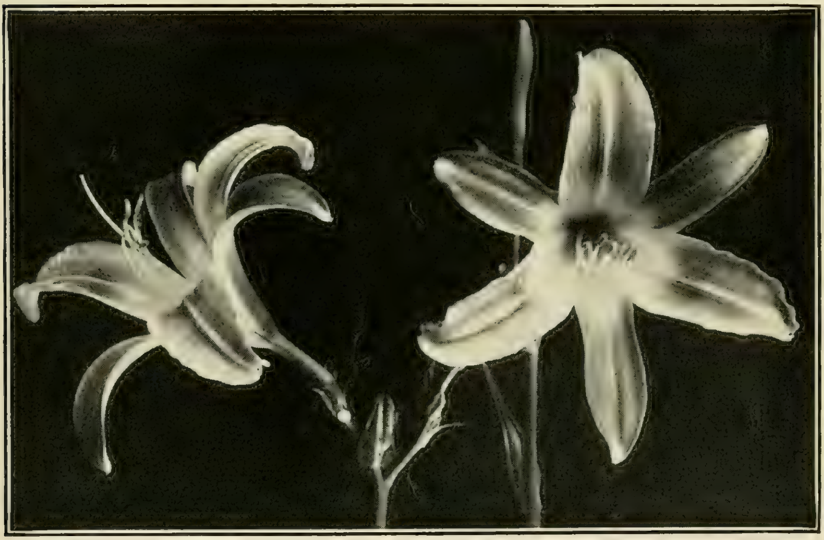

Figure 1. Flowers of the Cinnabar Daylily, showing face and side view, about one-half natural size. Some indication is given of the delicate coating of vinaceous-rufous coloring that covers the cadmium-yellow in the outer half of the face of the open flower.

At present there is no other variety in the trade that closely resembles the Cinnabar Daylily. It is judged to be the best for its particular grade of coloring among the many seedlings with fulvous colors now at hand for selection. Wider petals and fuller flowers would add somewhat to its value as a garden plant, and selective breeding is being carried on to this end.

The hybrid seedling which is now being propagated as the Cinnabar Daylily was one of about 150 seedlings obtained by crossing the old garden clon Luteola with a plant of *H. aurantiaca.* The Luteola Daylily is itself a hybrid, presumably between *H. Thunbergii* and a type known as *H. aurantiaca major.* The seedlings of this particular progeny are, hence, rather complex hybrids, with yellow-flowered and light fulvous-over-orange types in their ancestry. As was expected, the flower colors of the seedlings varied greatly. There were many shades of yellow and of orange both in clear colors and in an overcast of fulvous. In Cinnabar the fulvous coloring is more intensified than in the *H. aurantiaca* and this together with other good points makes the plant worthy of general culture.

The above is the first full description and account of origin of the Cinnabar Daylily to be published. A brief mention of the plant was made by the Farr Nursery Company in offering it to the trade in the autumn of 1930.

The New Daylilies Mikado, Wau-Bun, and Vesta

The two daylilies named Mikado and Wau-Bun were described and illustrated in color in a recent number of *Addisonia* (March, 1930, plates 487 and 488). Also mention of these and of the Vesta Daylily was made in *House and Garden* (January, 1929). Hence only a brief statement of their most striking characteristics needs to be made here.

The Mikado Daylily surpasses all other known daylilies in the bold color contrasts in its flowers. In the center of each petal there is a large area of purplish red which is in sharp contrast to the orange colors of the rest of the open flower. The flowers are rather large, full, and widely spreading. The plant blooms during July. In habit of growth it is semi-robust, with scapes almost three feet tall. The appearance of a plant is well shown in Figure 2.

The distinctive feature of the Wau-Bun Daylily is the unusual form of its flowers. The sepals are large and stiffly and smoothly recurving; the petals are much larger than the sepals, less re-

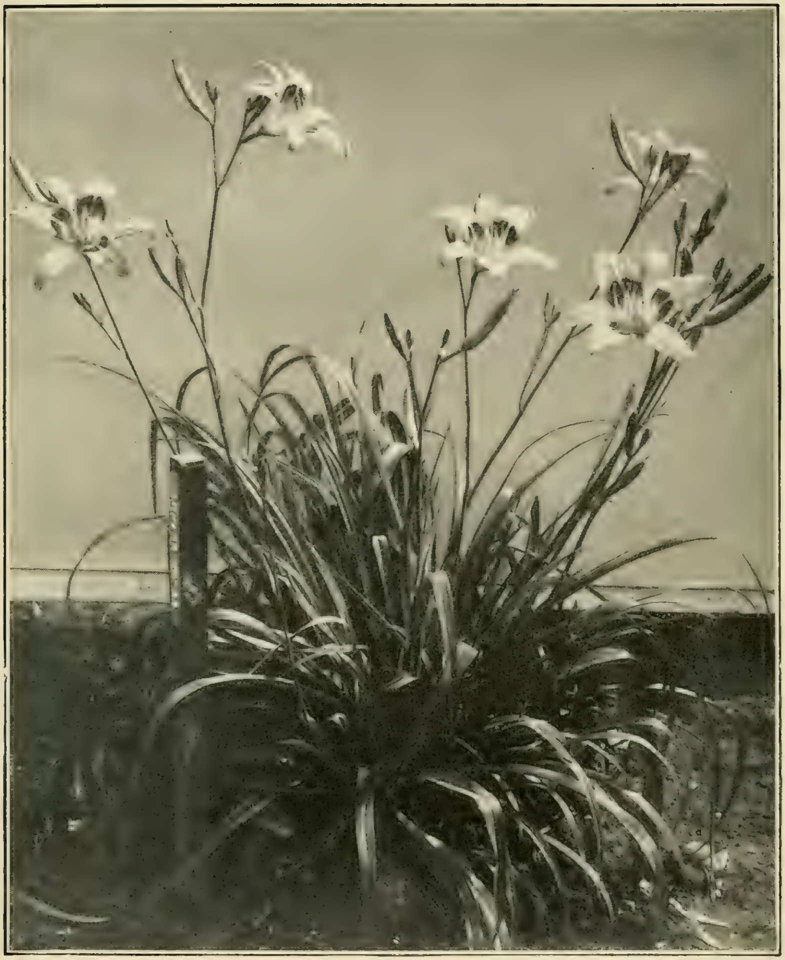

FIGURE 2. The Mikado Daylily has flowers of striking color contrasts. The large spots of mahogany-red in the petals combine to form an undulating zone of vivid color that is in sharp contrast to the rich orange of the rest of the flower. The flowers are large, full, and widely spreading.

curved, and toward the apex are folded backward along the midrib and somewhat twisted (see FIGURE 3). It is of some interest to note that in the first year of flowering the twisted and folded character was scarcely in evidence. Flowers of that year are shown in FIGURES 2 and 3 of the JOURNAL for August, 1925. The color of the flowers is light cadmium, slightly sprinkled with faint traces of fulvous red, and abundantly gold-glistening. The combination of color and form gives flowers of rare charm. The plant is semi-robust; the scapes are ascending rather than erect; the period of bloom in New York is July. The Wau-Bun Daylily has for its ancestry the two species *H. flava* and *H. aurantiaca* and the Luteola Daylily, but it is very distinct from any of these. The same form of flower has appeared in various other hybrids and some of these, together with Wau-Bun, are being used in further breeding.

The Vesta Daylily is a sister seedling to Wau-Bun but the two are so different that the relationship would scarcely be suspected.

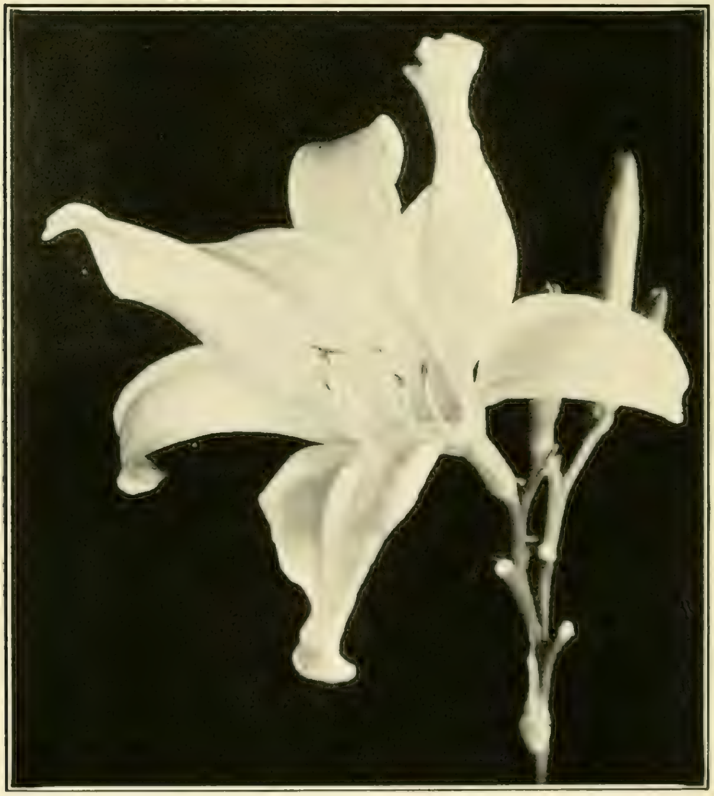

FIGURE 3. A flower of Wau-Bun Daylily, showing the unusual form characteristic of this plant.

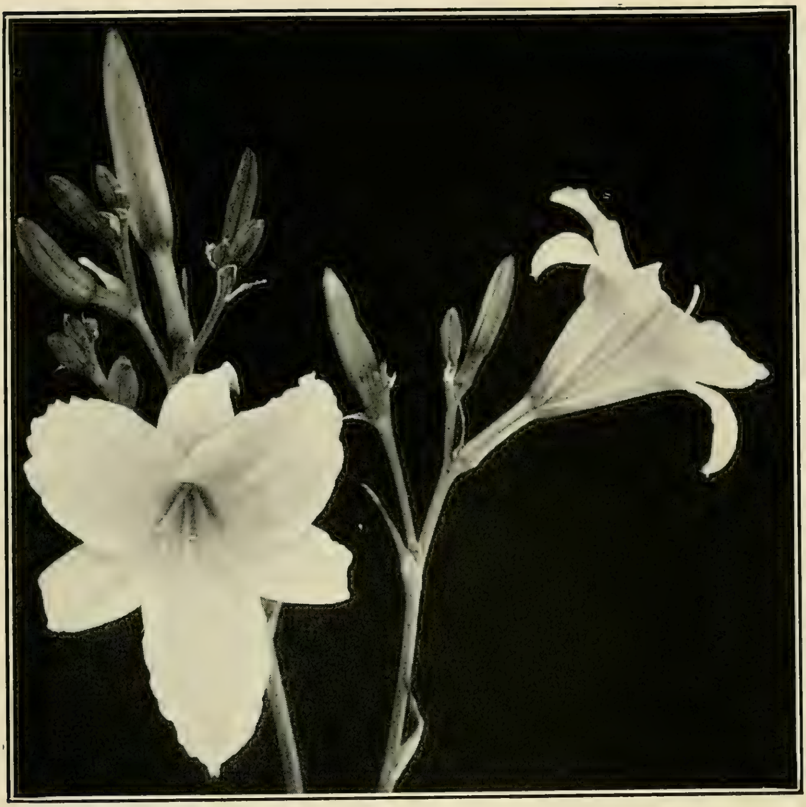

Figure 4. The flowers of Vesta Daylily are full, rich orange in color, and of good size.

Its flowers are full with the sepals and the petals broad and overlapping (see Figure 4) and their color is a deep orange with a slight trace of fulvous in the mid-zone. The spread of the open flower is about four and one-half inches. The plant has a compact habit of growth (see Figure 5) with scapes only about 30 inches tall. The season of flowering is July.

Further Selections of Choice Hybrids

About fifty different seedlings two or more years old are now under special observation as choice plants. These include a rather wide diversity of types as to size, color, and shape of flowers, season of flowering, and habits of growth. During the coming sum-

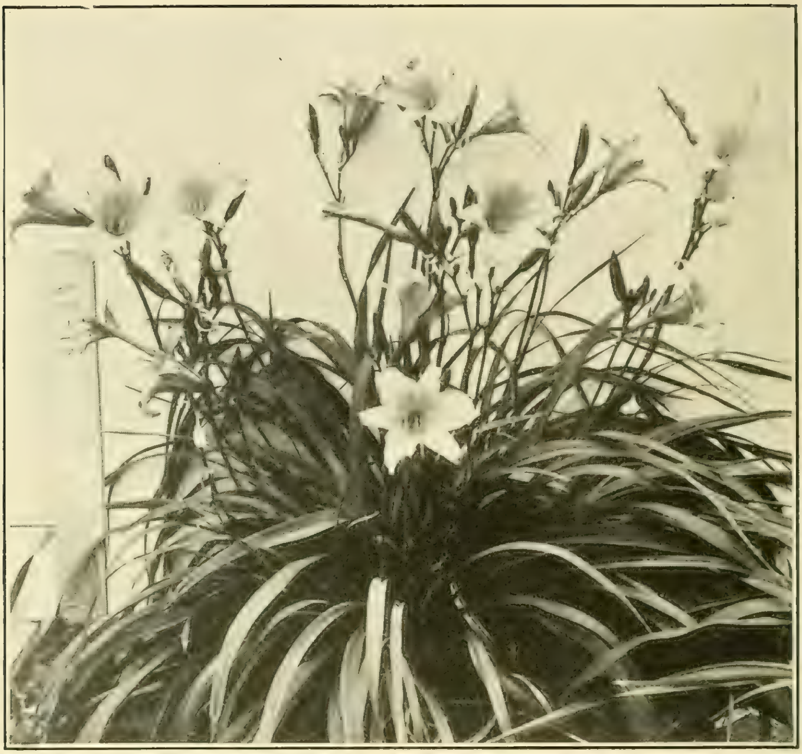

FIGURE 5. A plant of the Vesta Daylily. The habit is semi-dwarf and there are numerous flowers.

mer, numerous seedlings will bloom for the first time and these will be compared with the earlier selections. It requires, however, about three years of growth before a seedling daylily reveals its full stature, its habits of growth, and the size of its flowers.

It is the plan during the summer of 1931 to make selections of several plants with flowers of fulvous and red colorings. The seedlings of this class have attracted special attention from all who have seen them.

Thus far the Botanical Garden has not attempted to propagate daylilies for distribution. Each of the selected seedlings is divided and a half is taken by The Farr Nursery Company in exchange for plants of various sorts for use in the Botanical Garden. This company proceeds with the work of propagation until there is sufficient stock to offer to the trade. In the early period of the research, some fifteen years ago, Mr. Bertrand Farr encouraged the writer in his efforts in breeding daylilies and he greatly aided the progress of this work by supplying plants, some of which he obtained from abroad. Of various nurserymen who were approached at that time for aid he was the only one who gave support and sympathetic and constructive advice. The firm which has succeeded to the business established by Mr. Farr has continued to assist in the work and has made liberal exchanges of valuable plants other than daylilies.

There are many "good" seedlings which are not quite "excellent" in grade. It is the plan to assemble these in somewhat naturalistic display plantings in suitable locations in The New York Botanical Garden. This is a matter in which Mrs. Wheeler H. Peckham and Mrs. Harold McL. Turner of the Advisory Council are interested, and it is the plan that they will give attention to the grouping of the plantings according to color of flowers, habits of growth, and season of bloom.

A. B. Stout.

THE FANLEAF-PALM—WASHINGTONIA FILIFERA

Although the western side of North America was formerly much more difficult of access from the Old World than the eastern, early explorations were nearly simultaneous in the two widely separated regions. It may be that the fanleaf-palm was seen by European expeditioners as early in the sixteenth century as was the cabbage-tree of our eastern shores.

On account of the tardiness in the permanent settling of the western coast of America, the fanleaf-palm did not get recognition in American literature nearly as early as the cabbage-tree did. In fact, there seems to be nothing to amount to much until about the middle of the last century.

The references in American literature to the fanleaf-palm begin shortly before the middle of the last century. They occur as mere incidental mention of a palm-tree or group of palm-trees in the landscape. William H. Emory,[1] who was in charge of the expedition referred to in the foot-note below, recorded that:

"A few miles from the spring called Ojo Grande, at the head of the creek, several scattered objects were seen projected against the cliffs, hailed by the Florida campaigners, some of whom were along, as old friends. They were cabbage-trees, and marked the locale of a spring and a small patch of grass."[2]

A few years later in an account of exploration for a railroad route to the Pacific coast, William P. Blake,[3] the geologist of the expedition, records in the three following paragraphs:

" A growth of rushes forms a narrow margin of green vegetation around the spring and its outlet. Willows and mezquite-bushes grow there also; and I found a young palm tree spreading its broad, fan-like leaves among them. The surrounding desert, and this palm tree, gave the scene an Oriental aspect; and the

---

[1] William Hemsley Emory was born in Queen Anne County, Maryland, 9 September, 1811. Upon graduation from the United States Military Academy he entered the United States Army, in which he served for more than forty years, retiring with the rank of brigadier-general in 1876. His earlier years in the army were spent at various stations in the eastern states, but from 1848 to 1861 he was engaged in exploration and topographical work and border duty, chiefly along the United States and Mexican boundary. It was during this period, and especially while he was in charge of the Mexican boundary commission, 1848–53, that he made important scientific observations and collections, especially botanical ones. During the Civil War he was a general in the volunteer forces, returning to the regular army in 1868. He died at Washington, D. C., 1 December, 1887.—JOHN HENDLEY BARNHART.

[2] Notes on a military reconnaissance from Fort Leavenworth in Missouri to San Diego in California 103. 1848.

[3] William Phipps Blake was born in New York City, 1 June, 1826. He was a member of the first class of the Sheffield Scientific School, receiving the degree of Ph.B. from Yale in 1852. From 1854 to 1856 he was geologist for the Pacific Railroad surveys, and added much to the knowledge of the flora of the parts of California then visited by him, through his observations and collections of plants. In later years his geological work took him to North Carolina, Georgia, Japan, China, Alaska, and Santo Domingo; and he was long professor of geology at the University of Arizona. He died at Berkeley, California, 21 May, 1910.—J. H. B.

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JOURNAL
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THE NEW YORK BOTANICAL GARDEN

THE SO-CALLED CHINESE EVERGREEN—AGLAONEMA MODESTUM
E. D. MERRILL

BLACK STEM-ROTS AND LEAF-SPOT OF PELARGONIUM
B. O. DODGE
MARJORIE E. SWIFT

THE SOUDAN DAYLILY
A. B. STOUT

COLLECTING INSECTS IN HERBARIA
J. C. BRIDWELL

FOUR RECENT BOOKS REVIEWED
FORMAN T. MCLEAN

A GLANCE AT CURRENT LITERATURE

NOTES, NEWS, AND COMMENT

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as three centimeters below the point where the outward signs of the disease ceased, indicating that in controlling the trouble it is necessary to cut back a considerable distance from the visibly rotted area.

FIGURE 1, E, shows a plant twenty-three days after an inoculation, not with the stem bacterium, but with the organism isolated from typical bacterial leaf-spots such as illustrated in FIGURE 1, A and B. Of seven such inoculations, four gave positive results and the organism was re-isolated. Whether or not the organism causing stem-rot is identical with the one causing the leaf-spot is a question which must be left for further culture work and experimentation.

CONTROL OF BLACK STEM-ROTS

General control measures, such as careful watering, mentioned for the bacterial leaf-spot, should be effective also in the case of the stem-rot. Seriously affected plants should be promptly destroyed to remove sources of new infection, and the pots in which they were grown should be thoroughly sterilized. In cases of early infections, cutting back as far as possible from the infected area and treatment of the cut surfaces and of the soil with a fungicide such as Semesan should save the plants. Cuttings should not be made with an unsterilized knife which has been used in the vicinity of infected plants, and unnecessary wounding and rough handling should be avoided. The remedy suggested for control of the leaf-spot which involves the picking off of infected leaves only increases the probability of infection by the stem bacterium, if the leaf stalk is broken off close to the stem, leaving a fresh scar.

In case one is having trouble with black rots that attack the lower ends of cuttings (foot-rots) the soil is probably infected with one of the *Pythium* damping-off fungi, or with the virulent strains of the stem-rot or leaf-spot bacterium. The soil should be replaced or sterilized.

B. O. DODGE,
MARJORIE E. SWIFT.

THE SOUDAN DAYLILY

The Soudan Daylily somewhat resembles the old popular Lemon Daylily (*Hemerocallis flava*), but it blooms in New York in July after the former is entirely through flowering. In comparison with the Lemon Daylily the plant is somewhat larger, the scapes are taller, and the flowers have broader petals and this makes a fuller flower, but in general color and size the flowers are nearly the same. Hence those who are fond of the Lemon Daylily will find the Soudan Daylily of interest and value in continuing this class of plant and flower into the midsummer season.

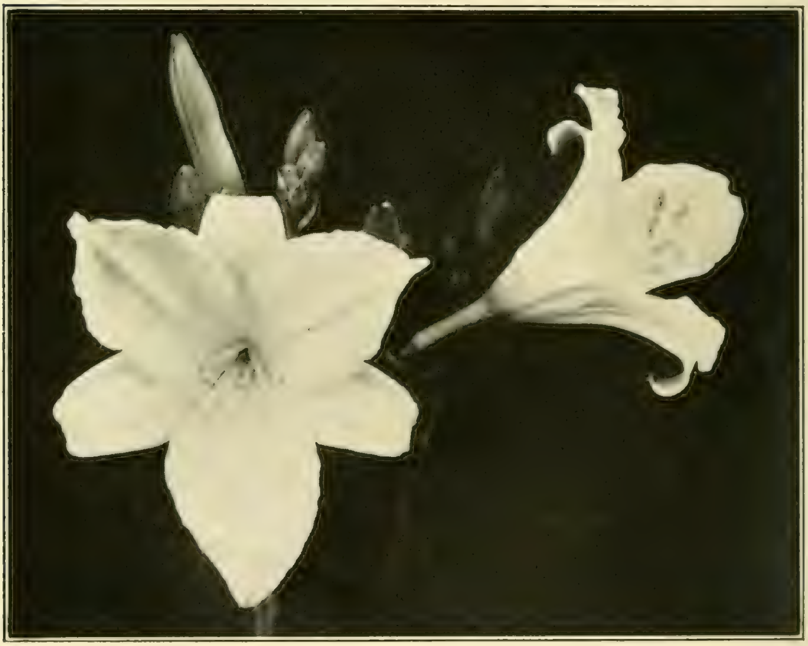

FIGURE 1. Flowers of the Soudan Daylily.

The foliage of the Soudan Daylily is medium coarse, medium dark-green, and ascending to a general level of about two feet. The scapes are about three feet tall, branching, nearly erect, and holding the flowers well above the leaves. The flowers are clear empire-yellow in color and gold-glistening; the petals have somewhat wavy margins, and they are wide and overlapping, making an unusually full flower with a spread of about four and one half inches. The plant is day-blooming, very floriferous, and an excellent summer-flowering sort.

In obtaining the seedling that is being propagated under the name Soudan Daylily, the *Hemerocallis flava* (Lemon Daylily) was hybridized with *H. aurantiaca* and a selection in this progeny was then crossed with the Luteola Daylily, which is itself supposed to be a hybrid between *H. Thunbergii* and either *H. aurantiaca* or *H. aurantiaca major.* The progeny of this diverse parentage had flowers of various shades of yellow and orange coloring, with, in a few cases, tinges of fulvous. Two of this particular series of hybrids have already been named the Vesta Daylily and the Wau-Bun Daylily.

The Soudan Daylily is the sixth of the various new hybrid seedlings developed at The New York Botanical Garden that have now been described and illustrated in the pages of this JOURNAL. Those already so described are Cinnabar, Mikado, Vesta, Wau-Bun (issue of Feb., 1931) and Bijou (issue of Jan., 1932). Several other seedlings of special merit are being propagated for possible distribution later.

A. B. STOUT.

COLLECTING INSECTS IN HERBARIA[1]

At first thought an herbarium might seem to be a poor place to collect insects; still, many insects find dried plants suitable for food—so much so that all modern herbarium specimens are treated with corrosive sublimate to prevent their destruction by insects or by moulds.

There are also several groups of insects which, feeding as grubs or caterpillars in the fruits at the time the plants are picked, may often be found in herbarium specimens. Among these are moths of several families, whose caterpillars feed on seeds and fruits and are imprisoned when herbarium specimens are made. These are, however, usually unable to complete their transformations and are only exceptionally of use to students of the Lepidoptera. Many snout beetles live in the same manner but most of them must transform from grub to beetle in the earth, hence we can usually learn but little about them from herbarium material.

---

[1] J. C. Bridwell, a private student of the seed weevils of the family Bruchidae, working with his headquarters in the National Museum at Washington, spent three weeks during October and November examining the legumes of the newly arranged Asiatic and Indo-Malayan Herbarium and collecting Bruchidae from the pods and seeds contained therein. [Ed.]

Some Cynipid gall-wasps make galls in the substance of seeds (particularly acorns), and several groups of Chalcidoidea (usually parasitic upon other insects) produce galls in seeds or feed directly on the substance of seeds. These Hymenoptera complete their transformations within the pods or seeds, and useful material of them can sometimes be obtained by the examination of herbaria. The snout beetles of the genus *Apion* include many species living in fruits or seeds.

The group most frequently found in herbaria are the seed weevils of the family Bruchidae, most often found in the pods or seeds of legumes. These beetles are, like the legumes, most abundant in tropical and subtropical regions, but some species reach northward into Scandinavia, Kamchatka, and Alaska.

The Bruchidae have worked out interesting methods of entering the immature seed as larvae and leaving it as adults after it has ripened. The eggs are usually cemented firmly to the pods about the time they have reached full growth but are still green. The eggshell serves as a point of support for the young larva in eating its way into the pod, bracing itself between the eggshell and pod by means of a transverse pectinate ridge on the first body segment, characteristic of the first larval stage of the Bruchids.

Once within the seed, the larva eats a surprisingly small portion of food for its size. Before pupating, it prepares the way for its own escape as an adult beetle by making a circular window, closed only by the cuticle of the pod or seed. It then compacts the débris resulting from its feeding by a cement, and the whole hardens into a coarsely fibrous silk-like cocoon. After it has transformed and is ready to emerge, the adult extends its head and with its sharp-pointed jaws traces a perfect circle around the membranous window separating it from the outside world,

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THE NEW YORK BOTANICAL GARDEN
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JOURNAL
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A. B. STOUT

AUTUMN IN THE GARDEN
ETHEL ANSON S. PECKHAM

FUNGI IN THEIR HUMAN RELATIONS
J. GARDNER HOPKINS

PHOTOSTAT COPIES OF CHARLES DARWIN'S LETTERS IN COX COLLECTION ARE SENT TO DOWN HOUSE
E. D. MERRILL

A GLANCE AT CURRENT LITERATURE
CAROL H. WOODWARD

NOTES, NEWS, AND COMMENT

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THE BIJOU DAYLILY, OF A NEW SMALL-FLOWERED RACE

The Bijou Daylily is a selection from many seedlings of a new horticultural race of small-flowered daylilies developed by hybridizations with the wild species *Hemerocallis multiflora.* This species[1] has small flowers and the scapes are slender and much branched, bearing numerous blossoms. These characteristics are decidedly in evidence in all of the F_1 hybrids having *H. multiflora* for a parent that have thus far been obtained. In regard to flower colors, a rather wide range of types of species and hybrids were hybridized with the *H. multiflora,* including some with fulvous and with red shades, and as a result yellow, orange, and fulvous red colors are all obtained in the various hybrids.

The progenies of the various hybridizations involving *H. multiflora* now comprise several hundred seedlings. These provide excellent material for further selective breeding, especially in the efforts to obtain plants with still smaller flowers of greater number per scape, and such breeding is now in progress. But several of the most attractive seedlings already obtained seem worthy of general culture and these are now being propagated. One of these has been given the horticultural name Bijou and this plant is here described in print for the first time.

The seedling to be propagated as the clon Bijou Daylily is now only two years old and it has thus far been grown on rather poor soil. It has shown a noteworthy vigor in the rapid spread of rootstocks in the crown, which makes for rapid propagation. The scapes have reached a height of about two feet, which is consider-

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[1] The species *Hemerocallis multiflora* was first described and illustrated with a colored plate in Addisonia (**14** : *pl. 464* J. 1929.) Later this species was discussed and illustrated by photographs in the Journal of The New York Botanical Garden **31** : 34–39.

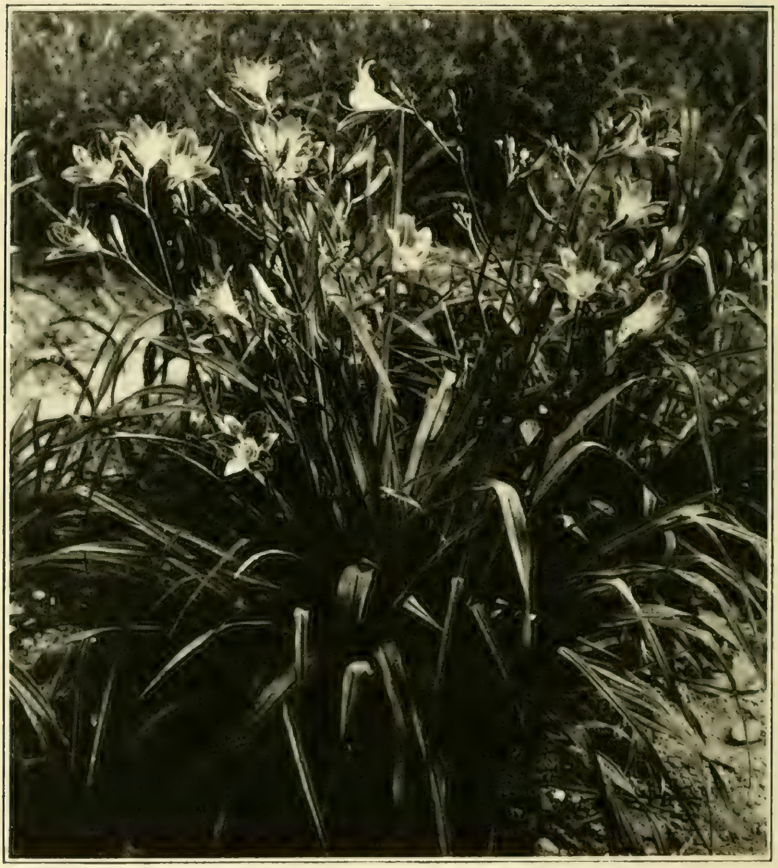

FIGURE 1. The original seedling of the Bijou Daylily.

ably lower than the scapes of most of the F_1 hybrids of *H. multiflora.* The scapes are stiffly erect and much branched and they bear numerous flowers which average about 2½ inches in spread. The flowers are full, and the segments are spreading but not strongly reflexed. The ground color is a shade of orange, showing clear in the throat of the flower but otherwise strongly overcast with rich fulvous red in a combination of sprightly color effects. The season of flowering is in July. The foliage is abundant, rather erect-ascending, with the upper levels only slightly below the flowers.

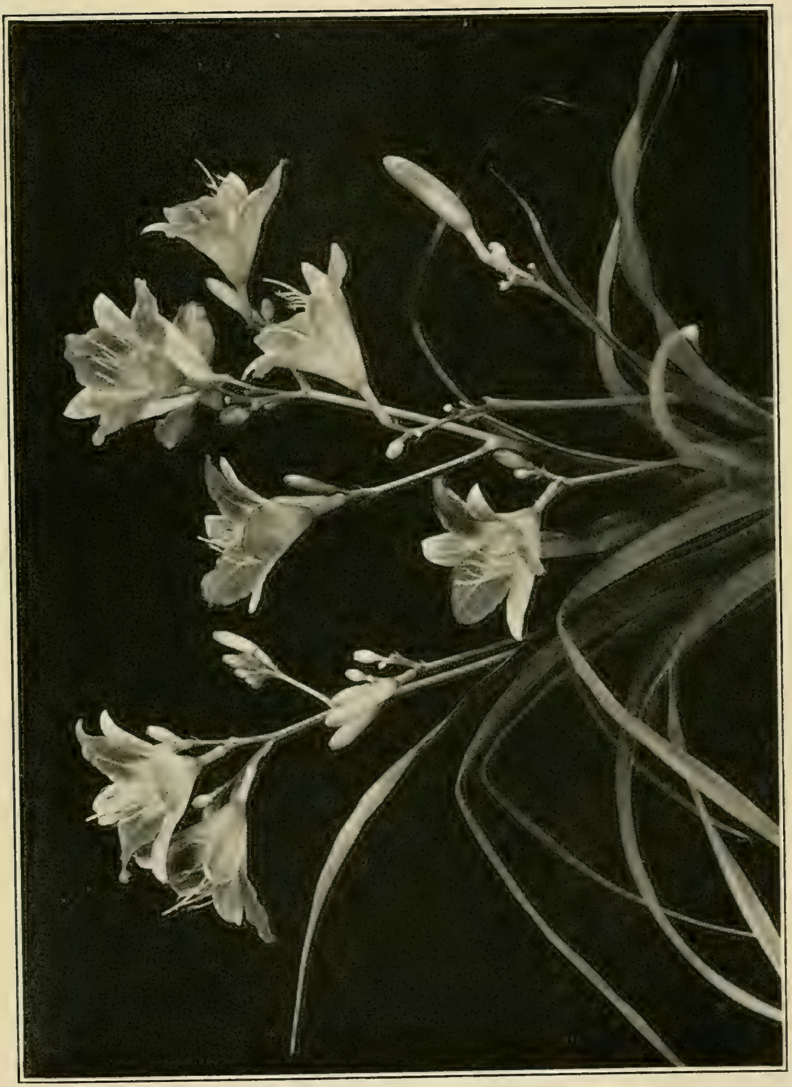

FIGURE 2. Flowers of the Bijou Daylily.

The seed parent of the Bijou is a sister seedling of the Mikado Daylily (see Addisonia 15: *pl. 487*) and it is a complex hybrid having in its immediate ancestry the species *H. aurantiaca, H. flava,* and *H. fulva* clon Europa. The plant of *H. multiflora* used as the pollen parent of the Bijou Daylily has tall, erect, much-branched scapes and it is somewhat earlier in blooming than the other plants of the species.

The Bijou Daylily is a hybrid with four distinct species involved in its parentage. As to flower color it is to be classed as fulvous; in flower size it is very similar to the *H. multiflora* but the flowers are of a different shape. In its general ensemble of characters, the Bijou Daylily is a somewhat distinct and new type among the horticultural daylilies.

A. B. Stout

AUTUMN IN THE GARDEN[1]

There are several things one thinks about in connection with autumn in the garden: the flowers that are in bloom then, the berried shrubs and fruiting trees, the gay coloration of leaves, the work that *must* be done with dispatch before the ground freezes too hard to manage and, above all, the planning for spring.

Among flowers that make our gardens gay, there will still be with us in early autumn, asters. Those Michaelmas daisies that bloom with us long before Michaelmas! Evolved from our own wild American asters, they have come to us from overseas and are now available in many good named varieties. One can get them tall, medium, and dwarf, large- or tiny-flowered, in all tones of mauve and bluish-pink and rose, starry-flowered and fluffy-flowered. Excellent they are, but one should be careful not to uproot them in spring, as their leafy rosettes, naturally, are exactly like those of their ancestors, a noxious weed to our minds, and if not carefully labeled or if the memory be short, up they come and later wails will be plentiful when it is found the "daisies" are gone. Other flowers to bloom are colchicums. They send up their leaves in springtime and bloom in autumn with a

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[1] Abstract of a lecture given at The New York Botanical Garden on December 5, 1931.

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CONTRIBUTIONS FROM THE NEW YORK BOTANICAL
GARDEN—No. 329

CHROMOSOME NUMBERS IN *HEMEROCALLIS*, WITH REFERENCE TO TRIPLOIDY AND SECONDARY POLYPLOIDY

By

A. B. STOUT

NEW YORK

1932

Reprinted, without change of paging, from "CYTOLOGIA"
3: 250–259. June, 1932

Chromosome Numbers in *Hemerocallis*, with Reference to Triploidy and Secondary Polyploidy

By A. B. STOUT
The New York Botanical Garden

Received February 22, 1932

The condition of triploidy in certain members of the fulvous daylilies has been reported by Belling (1925) and by Takenaka (1929). Evidently Belling studied the Linnaean type of the species *Hemerocallis fulva* that has long been propagated asexually as a garden clon in Europe and America and for which the writer (1929 *a*) has suggested the horticultural name "Europa Daylily". Takenaka reported triploidy in what he calls the *H. fulva* of Linnaeus, in a double-flowered clon which he calls *H. disticha* var. *Kwanso*, and in another but unnamed type. Both Belling and Takenaka agree that the triploid number in the plants they studied is 33 and their assumption is that there are three sets of 11 each.

Takenaka also reports a diploid number of 22 for plants of *H. flava*, which is in agreement with the number reported by Nawaschin (see Tischler, 1927), and for plants considered as *H. aurantiaca* Baker, *H. Middendorffii* Traut. and Mey., *H. disticha* Donn, *H. longituba* Miq., and *H. minor* Miller.

A rather extensive survey of the chromosome numbers has now been made by the writer* for the species, several clonal varieties, and various seedlings of *Hemerocallis* assembled at The New York Botanical Garden which shows (1) that a somatic number of 22 chromosomes is the rule for all species of the genus, (2) that triploidy exists in several of the cultivated clons of fulvous daylilies, and (3) that diploids, triploids, aneuploids and para-triploids are to be obtained among the seedlings of diploids crossed with triploids.

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* The author is indebted to assistants for the preparation and preliminary study of the cytological material and especially to Miss Clyde Chandler, technical assistant to the writer.

The Purely Diploid Species

Twenty-two chromosomes have been found to be the rule in the early equatorial plates during the mitoses of root-tip cells for all individuals thus far studied of the following species:— *Hemerocallis flava, H. minor, H. Dumortierii, H. Middendorffii, H. aurantiaca, H. Thunbergii, H. citrina, H. Forrestii, H. multiflora, H. nana* and *H. plicata.* In various cases deviations in the number were observed giving counts of 21, 22, 23 and 24 for the same plant. Descriptions with colored plates of all the types of these species which were studied, except for the two named last, have been published (Stout, 1929*c*, 1930).

The Species *Hemerocallis fulva*

It is now certain that the cultivated horticultural plant described by Linnaeus as *Hemerocallis fulva* is merely a triploid clon which is so completely self-incompatible that it never produces seeds to self-, close-, or intra-clonal-pollinations. That the original plant of this clon was derived from some diploid species is obvious. A survey of the fulvous daylilies closely related to this Europa Daylily has already been presented by the writer (1929*a* and *b*) and this indicates that a somewhat variable wild type of fulvous daylily is widely distributed in China and Japan which may be considered as the species *H. fulva.* This group would include the *H. disticha* of Donn, and the *H. longituba* of Miquel.

Living plants, showing a considerable range of minor variations, but all here considered as included in the species *H. fulva,* have been obtained from various localities in China and Japan. In several cases these plants came from what was certainly wild stock reproducing by seeds. No two plants were exactly alike and seeds were readily obtained by intercrossing. In these plants the normal number of diploid or somatic chromosomes is 22.

The Europa Daylily. It seems very probable that all of the various cytological studies, at least by investigators in Europe and America, previously reported for "*H. fulva*" have been made on plants of the one clon, the Europa Daylily. The estimates of the haploid chromosome number, based on the grouping of chromatin units in the reduction divisions, have been 12 (by Strasburger, 1882; Timm, 1928), 16 (Tischler, 1927), and 24 (Schürhoff, 1926, p. 461). Belling (1925) was the first to interpret the grouping of chromosomes in this plant during meiosis as fluctuating about the number eleven. In the prophases of the second division he made some counts of 33 split or X-shaped chromosomes and concluded that the plant is a triploid, but he notes that it is an irregular triploid with varying numbers of trivalents, bivalents, and univalents in meiosis.

A somewhat extensive study of the many irregularities in chromosome behavior in the stages of sporogenesis and in somatic divisions for plants of the Europa Daylily was reported by Stout and Susa (1929) in which it was considered that the variations arise from a basic somatic number of 12 as a result of fragmentation, non-distribution, and non-disjunction. A total of only six chromatin masses were sometimes found in the equatorial plate of the first division in meiosis, groups of six apparently single chromosomes were frequently seen in the late stages of the second division, and in these stages a total of 24 was frequently found. Also in the division of the primary nucleus of the pollen grains a minimum number of 6 was found. Variations were also found in the number of chromosomes in somatic cells where the number frequently rises well above 33, and especially in the older tissues of the root-tip there is evidence of variation to lower numbers due to non-distribution. But a further study of the same plants now shows that 33 chromosomes are usually to be found in the early stages of the equatorial plate in somatic divisions especially in the undifferentiated tissue or close to it. Since the somatic number for the other species and for the wild plants of the fulvous type is 22, the haploid number characteristic of the genus *H. fulva* is to be considered as 11 and the clon Europa is to be regarded as a triploid.

A group of triploid plants all identical in character and evidently of a single clon was obtained from Takyu, Korea, through the kindness of Mr. T. Susa. The flowers of these plants appear to be the same, or nearly the same, as those of the Europa Daylily but further comparison awaits the time when these plants become well established and of mature stature. The clon Europa was in cultivation in Europe as early as 1576 (Lobel, 1576) but it is possible that it also exists widely as a cultivated plant and as an escape in the Orient.

The clon Maculata. This clon was derived either from seed or from a living plant sent from Shen-si, China to Florence, Italy about 1897. Although originally described as a true botanical variety, the plant has only been propagated vegetatively as a garden clon. The Maculata Daylily (for colored plate and more complete description see Stout, 1929 *c*) closely resembles the Europa Daylily but the flowers are larger, slightly different in coloring, and the flowering begins somewhat later in the summer. There is much abortion of pollen, and there is complete self-incompatibility, but fruits and a limited number of viable seeds per capsule are readily obtained from certain compatible cross-pollinations.

The chromosome counts in the root-tips of plants of this clon are most frequently 33 and the clon is evidently a triploid.

The double-flowered fulvous daylilies. The varietal names "*Kwanso*" and "*flore-pleno*" have been given to certain double-flowered daylilies that are very similar to the Europa Daylily in habits of growth and flower colors. These are propagated exclusively by division and have evidently long existed in China and Japan where they appear to have escaped widely from cultivation. Plants of the double-flowered type were not brought to Europe and America until about 1860 (see Stout, 1929 *a*). Plants have been received at The New York Botanical Garden under the names "Kwanso" and "Flore Pleno" from various nurserymen and from various botanical gardens. The counts of chromosome numbers in root-tips of these have, as a rule, been 33, as reported for the plants of "Kwanso" studied by Takenaka. A study of the cytology of sporogenesis in "*Hemerocallis fulva fl. ploeno*" by Sienicka (1929) reports "16 gemini" in stages of diakinesis and many irregularities in the later stages of meiosis and spore formation. It seems very probable that the plant studied by Sienicka is a member of one of the triploid clons.

A double-flowered fulvous daylily having variegated foliage was mentioned in the Gardeners' Chronicle in 1864, under the name "*H. Kwanso foliis variegatis*". Possibly the original plants of the so-called "*H. fulva Kwanso*" brought by von Siebold directly from Japan to Europe shortly before 1864 were variegated, for the variegation is evidently of the chimeral type and the plants frequently produce all-green branches. The root-tips of several plants of the variegated type have been examined and in these the number of chromosomes is 33.

Seedlings of Crosses between Diploids and Triploids

The triploid clons Europa and Maculata are evidently fully self- and cross-incompatible but they have been used both as seed and as pollen parents in crosses with certain diploids.

As a seed parent the Europa Daylily crossed with diploids has given for the plants thus far studied—

five seedlings with somatic number of 22,
two with somatic number of 22–23,
two ,, ,, ,, ,, 22–24,
one ,, ,, ,, ,, 26–27, and
one ,, ,, ,, ,, 21–28.

Of the seedlings having the Europa Daylily as a pollen parent and thus far studied—

nine seem very constant for the number 22,
one gives counts of 20–21 with also numbers rising to more than 40,
one gives counts of 29–32, and
one gives numbers of 31–33.

Eleven seedlings having the triploid Maculata Daylily as one parent have been examined—

ten are quite regular for the number, 22, and
one has numbers as high as 33.

Of the seedlings which have triploid double-flowered daylilies as a pollen parent and diploid plants as seed parents—

eight are apparently rather uniformly diploids,
one gives counts of which the numbers 12, 15, 22 and 23 seem definite, and
one appears to be triploid.

The evidence seems to indicate rather definitely that for the triploid daylilies the gametes which function in fertilization most frequently carry 11 chromosomes but that the number in such gametes may vary and rise to at least 22. In only one or two seedlings is there evidence that the most frequent somatic number may be less than 22. When the range in the somatic number of chromosomes is 12–23, 21–28, and 31–33 it is not certain what numbers were in the gametes that entered into the fertilizations.

It may be stated that in every case the F_1 seedlings obtained by fully controlled cross-pollination between the Europa Daylily and non-fulvous daylilies, such as *H. flava*, *H. citrina*, and *H. Thunbergii*, either as a seed or as a pollen parent have all had flowers with some degree of fulvous coloring. This does not agree with the results reported by Blaringhem (1928) to the effect that F_1 hybrids of similar crosses may have yellow flowers.

Undetermined Types of Daylilies

Several groups of daylilies grown from seeds or from divisions obtained from various sources in the Orient are not readily to be assigned to any of the species now known. Some of these may be selections of horticultural origin that are being cultivated as clons but several plants were obtained from seeds collected in the wild. In all of these plants thus far studied the chromosome number is almost uniformly 22 except for one plant in which valid counts of 22, 23 and 24 were made.

Named Horticultural Clons

Chromosome numbers of 22 have been found to be the rule in the root-tip cells of the following clonal varieties:—*aurantiaca* Major, Aureole, Luteola, Mikado, Mulleri, Sirius, and Vesta. The study of chromosome numbers in the various clons in cultivation is being extended.

Summary and Discussion

The normal or most usual number of chromosomes in the somatic cells of all the species of *Hemerocallis* now known is 22. But several clons of the fulvous daylilies in cultivation or growing as escapes from cultivation are triploids and at least in certain of these there is considerable variation in the number of chromosomes, both in somatic cells and in the various cells involved in sporogenesis.

The triploid clons comprise (I) the single-flowered (*1*) Europa Daylily and the (*2*) Maculata Daylily, and (II) the double-flowered types known under the names (*1*) Kwanso, (*2*) Flore Pleno, and (*3*) Variegated. All of these are noticeably similar in vegetative habits and in the color of the flowers, and they all obviously belong to the somewhat variable wild species *H. fulva*. Whether these types have a common origin from a single triploid or a separate origin is not definitely known. There are slight but consistent differences between the Europa Daylily and the Maculata Daylily in habit of growth, in the precise character of the flowers, and in the season of flowering, and these two daylilies differ from the double-flowered types especially in having single flowers. It is possible that such differences may have arisen by somatic variations during a long period of clonal propagation, but it is also quite possible that the Europa Daylily, the Maculata Daylily, and the double-flowered type arose as different seedlings. Yet these clons are fully cross-incompatible, and it would seem that there is a close relationship and that they possess in common at least some of the same hereditary factors for incompatibility.

Thus far no seedling has been obtained from the numerous self- and cross-pollinations involving only these triploids. There is much abortion of pollen in these triploids but there appears to be complete self- and cross-incompatibility for those spores and gametes which are functional—a type of sterility very common in daylilies. Offspring have been obtained by crossing triploids with certain diploids, and chromosome counts have been made for 44 of these seedlings. The majority of these seedlings are diploids, a few are triploids, and several are aneuploids with somatic numbers that are fluctuating for various numbers between the diploid and the triploid. In several plants there are individual cells with higher than the triploid number or with lower than the diploid number but no plant seems to be reasonably uniform for such a number. Thus in one plant counts of 12, 15, 22 and 23 seem valid but the lower numbers are not sufficiently frequent to admit of a decision that the plant is, or ever was, fundamentally a para-haploid or a sub-diploid.

From the chromosomal complex of the seedlings of triploid- diploid parentage it seems clear that for the triploids the chromosome number in the spores and gametes which mature and function is most frequently 11, that a few of the gametes may have 22, and also that various numbers between 11 and 22 may be present in functional spores. The cytological evidence for the triploid Europa Daylily clearly shows that abortion during sporogenesis eliminates many nuclei and especially those with few chromosomes, but it is certain that spores with as few as six chromosomes (Stout and Susa, 1929) may develop at least to the stage of the division of the primary cell. It may perhaps be assumed that gametes with less than 11 and with more than 22 chromosomes may sometimes mature and be functional.

The existence of self- and cross-incompatibility in these triploid daylilies greatly limits the chance of obtaining offspring from the fusion of two gametes both of which have higher than, or less than, the set of 11 chromosomes. As long as the seedlings obtained have one parent which is diploid there is little chance of advancing to higher levels of polyploidy. Attempts will now be made to obtain seedlings between triploids by utilizing the new seedlings that are triploids or para-triploids. It is obvious that pollen abortion and incompatibility in fertilization have operated to restrict and prevent the further extension of polyploidy in the long period of time during which the older triploid clons have been under cultivation.

Evidence seems to be accumulating to the effect that various plants, ordinarily considered as diploids, are in reality secondary polyploids. The case of the wild and cultivated apples may be cited in this respect. In the family Rosaceae the low basic numbers of chromosomes appear to be 7 and 8, but in the apples the rule is that the somatic number is 34 with a few cultivated clons in which the somatic number is 51. Nabel (1929 *a* & *b*; 1930) has concluded that the haploid number of 17 here seen was developed from a smaller basic number of 7 giving a "halved pentaploid origin". Darlington and Moffett (1930), from a study of the associations of chromosomes in meiosis, conclude that four chromosomes of a basic seven were duplicated and three were triplicated. They find however that 13 seedlings of the triploid apple "Bramley's Seedling", presumably crossed with a haploid, possess somatic numbers of 38 for two, 39 for one, 40 for three, 41 for four, 43 for one, 46 for one, and 47 for one and on this basis it appears that the spores and gametes of the triploid which functioned were 21, 22, 23, 24, 26, 29 and 30. Darlington and Moffett consider that the slightly greater frequency for 41 $(2(17)+7)$ is also significant in indicating a basic number of 7.

Various reports similar to the above seem to indicate that the numbers of chromosomes in the functional spores of polyploids do not tend to involve numbers lower than that which is haploid. It also seems that this holds for the cases of assumed secondary polyploids, as for the apples cited above. There are, however, during sporogenesis distributions of low numbers to many nuclei which abort. The stages of polyploidy seem to progress more readily than to regress. Yet it is possible that extended and persistent efforts to secure seedlings of polyploids in daylilies may sometime give a functioning of spores with such a low number as 6, with attendant genetic results of value in breeding.

In respect to the haploid number of 11 the genus *Hemerocallis* is an anomaly in the *Liliaceae*, for of the numerous genera of this family a diploid number of 22 chromosomes is characteristic only for this genus. According to the summary compiled by Gaiser (1930) the haploid numbers characteristic of large genera of the Lily Family are principally 4, 6, 7, 8, 9 and 12. Of these the numbers 7 and 9 do not conform to simple or complete duplication of more elementary sets. The number 5 is reported for the species *Disporum Hookeri*. The number 10 is found in certain species of *Calochortus* but for others the numbers 7 and 14 are reported. Haploid numbers of more than 12 are frequent in various genera with, in various cases, rather conclusive evidence of polyploidy. Thus in *Ornithogalum*, species with 6, 8, 9, 14, 16 and 27 haploid chromosomes are reported, and also there are variations in numbers for individuals of certain of the species. The somatic numbers in *Hyacinthus*, especially in the cultivated clons, are reported to include such numbers as 18, 19, 21, 22, 23, 24, 25–26, 27, 28, 30 and 36. Here, however, the so-called basic set of 8 is itself composed (Darlington, 1926) of 4 classes in respect to size and position of constrictions in the numbers 3 : 1 ; 2 : 2, which is evidence of irregular and incomplete duplication. The loss of one chromosome of the haploid set characteristic of a genus seems evident in the two species of *Allium* which have a number of 7. Marked variation within a species seems evident in various cases such as in *Tricyrtis hirta* for which numbers of 6, 12–13 and 13 are all reported. It is obvious that in the genera of *Liliaceae* the numbers of chromosomes suggest the basic numbers of 4 and 6 from which many grades of polyploidy have developed.

For the near relatives of *Hemerocallis*, haploid numbers of 12, 16 and 24 have been reported for species of *Hosta* (including *Funkia*). Also the haploid number of 12 is the rule for all the species of *Lilium* except that the clon called *Lilium tigrinum* is reported to be a triploid of 36 somatic chromosomes (Takenaka and Nagamatsu, 1930). The haploid number of 12 in various genera could have developed either by a duplication of a basic number of 6 or by a triplication of the still lower number of 4, and in either case a loss of one could give the compliment of 11 seen in *Hemerocallis*.

The chromosomes in *Hemerocallis* are very similar in size and shape and they offer few or no distinguishing features that allow ready identification of possible duplication or fragmentation as is the case for certain other genera of the Lily Family, as *Hyacinthus* (Darlington, 1926) and *Yucca* (Bonnet, 1911). In the processes of sporogenesis in the triploid Europa Daylily there are extreme variations in the number of chromatin masses. In the early stages of the equatorial plate of the first of the reduction divisions as low as six aggregates are to be observed. In the late stages of the second division groups of 5, 6 and 7 chromosomes are frequent. It is definitely known that spores with the low number of 6 chromosomes may survive at least to the stage of the division of the primary nucleus. There is thus numerous and various groupings of chromosomes in numbers below as well as above the number, 11, all of which strongly suggests that some lower number may be the basic group from which the present association of the somewhat anomalous number of 11 has been developed. It seems probable that this number was 6 of which 5 were duplicated.

Jan. 27, 1932.

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THE NEW DAYLILY TARUGA

in Horticulture
January 15, 1953.

THE NEW DAYLILY TARUGA

THE daylily Taruga is a recent selection from many seedlings having large flowers with distinctly folded and twisted petals. The first noteworthy seedling with this type of flower obtained by the writer was named Wau-Bun. This was first mentioned and illustrated in 1929 and it was more fully described with colored plate in 1930 (Addisonia 15: plate 488). It is now in the trade.

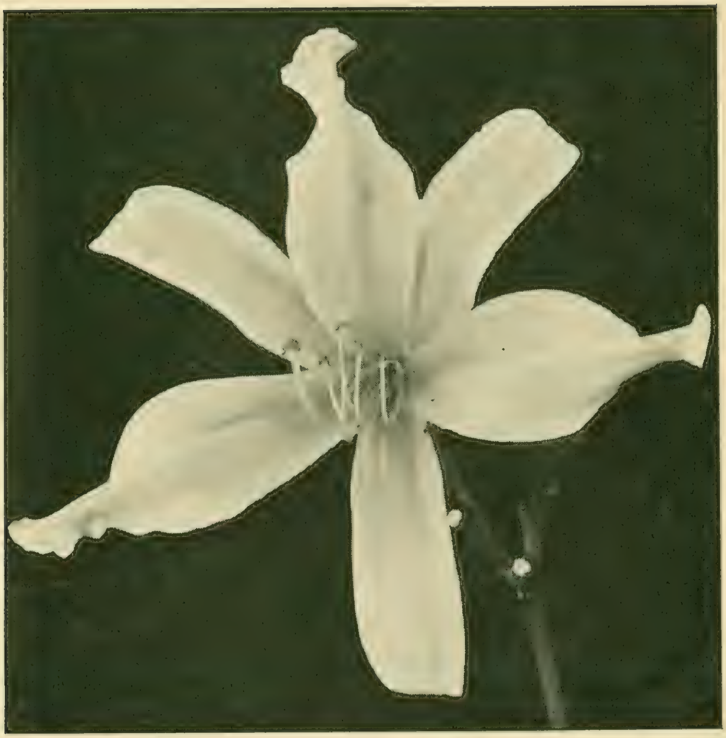
Wau-Bun was crossed with about 40 types of the daylily, the object being to obtain a twisted type in varieties of various habits, seasons of bloom, colors and sizes. One progeny with the large-flowered and rather robust variety Yellow Hammer as a parent contained many fine seedlings some of which have twisted petals. Of these the seedling now named Taruga is perhaps most distinctive. It was selected by Mrs. Barnabas Bryan, Jr., in 1931 as the most outstanding and best daylily then (July 14) in flower in the experimental plots or in the collection of varieties at the New York Botanical Garden. Mrs. Bryan suggested that the ancient Peruvian-Indian (Quichua) name Taruga, meaning deer, be used for the horticultural name of the plant.

Taruga is semi-robust with erect, well-branched scapes and about three feet tall. The flower is spreading to a width of about six inches. The petals are about four and one-half inches long and one and one-quarter inches wide and they are somewhat folded on the midrib and twister. The color is a clear lemon-yellow with a very faint and hardly noticeable tinge of fulvous in the midzone.

The season of bloom of Taruga is during the middle and the latter part of July, and in northwestern Connecticut the flowering extends into the first part of August. Compared with Wau-Bun, the flowers are less full, the color is more nearly yellow, the flowering period is later, the plant is slightly more robust and it spreads more rapidly in the crown. This is the first description and illustration of Taruga.

—A. B. Stout.

The New York Botanical Garden.



The Open Flower of the New Daylily Taruga

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THE FLOWERING HABITS OF DAYLILIES

The generic name *Hemerocallis* and the common name "daylily" recognize and emphasize the observation made by gardeners long ago that the individual flowers of certain of the plants thus named are *day-blooming*.

An early volume (Plantarum seu Stirpium Historia, 1576, by Lobel) definitely mentions the two members of this group of plants then known to European gardeners. One of these plants was called *Liriosphodelus phoeniceus* and Lobel states that the names "Hemerocalis" and "Ephemerum" were commonly applied to this particular plant because of the fact that the fugacious flowers last for scarcely a day. Of the flower behavior of the other type mentioned under the name *Liriosphodelus luteus liliflorus,* the Lemon Daylily of today, Lobel makes no mention.

Fifty-three years later John Parkinson, writing especially of plants in English gardens (Paradisi in Sole, 1629), describes the same two daylilies under the names "*Liliasphodelus phoeniceus,* the gold red Daylilly" and "*Liliasphodelus luteus,* the yellow Daylilly." Of the former he says that the flowers open "but for a day, not lasting longer, but closing at night and not opening again; whereupon it had his English name 'The Lilly for a day.'" Of the other type he states that the flower "abideth blowne many daies before it fade." Later he remarks, "In English we call them both Day Lillies, but the name doeth not so well agree with the last, as with the first, for the causes above specified."

In establishing the modern generic name for these plants, Linnaeus (Species Plantarum, 1753) selected the old appellation *Hemerocallis,* meaning in its Greek derivation *beautiful for a* *day.* Of the fulvous daylilies, he knew only the one clon then in cultivation, and for a time he considered it a hybrid, but later he gave it specific rank under the name *Hemerocallis fulva* (Species Plantarum, 1762).

Thus the habit of diurnal flowering observed for the "Gold Red Daylily" in cultivation is responsible for the generic name *Hemerocallis* and for the common name "daylily" as applied to this group of plants.

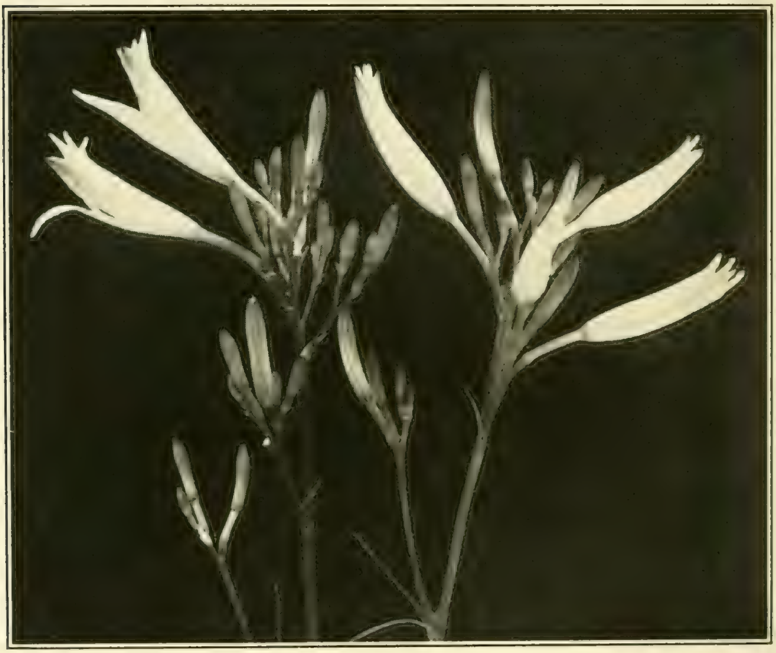

FIGURE 1. Flowers of *Hemerocallis citrina* are nocturnal. They open shortly before sunset, are fully open during the night, and close early the next afternoon (as shown here), unless the day is cool.

Soon after the introduction into Italy about 1897 of the species which was named *H. citrina,* it was recognized that its flowers are night-blooming. A Japanese book, the Somoku-Dzusetsu (second edition, 1874) had already described, incorrectly, under the name *H. Dumortierii,* a daylily whose flowers open in the evening and close early in the following forenoon. Later, in the third edition of this book, the name for this daylily was given as *H. minor,* which may also be incorrect. The Japanese names for this plant are given as "Yunsuge," meaning Evening Daylily, and "Matsu-yoi-gusa," meaning Waiting Evening Herb. Thus a nocturnal habit of flowering is to be recognized as characteristic of certain members of the genus *Hemerocallis.* There are then nightlilies as well as daylilies, or perhaps one may say there are night-blooming daylilies.

It is the rule for all the daylilies now known that a new set of flowers opens, or begins anthesis, at some time each day throughout the greater portion of the period when a plant is in flower. There are however distinct differences among species and clonal varieties in respect to the hour of the day when the sets open and close and in regard to the length of time during which they remain open, especially in reference to the daily periods of sunlight and darkness. In general there are three main habits of flowering among the daylilies:—(1) the diurnal or day-blooming, (2) the nocturnal or night-blooming, and (3) the extended blooming.

The diurnal habit of flowering is well exemplified in the clon of *H. fulva,* whose flower behavior was so clearly reported by Lobel and by Parkinson. It is now known that this plant is merely a horticultural clon and that it is a triploid variant of a variable species widely distributed in the Orient. To distinguish it from the various other somewhat different daylilies of the same species, the name Europa Daylily is now being used. Its flowers open after sunrise, usually about the time when direct sunlight begins to reach the plants, and these flowers close promptly about the time of sunset and before darkness ensues. There is little deviation from this schedule except that there is some delay in the opening when the weather is cool and cloudy. The diurnal habit is seen also in all the other members of the species *H. fulva* which the writer has observed, and these include the double-flowered daylilies, the clon Maculata, and about 100 individuals from the wild in China and Japan. There are only slight variations among these in the exact time of opening and closing. All are diurnal.

The cultivated clon of a second species of fulvous daylily known as *H. aurantiaca* may be classed as diurnal. The flower buds start to open during the hours before sunrise but they usually remain semi-open until after daylight. They close somewhat later than the flowers of the Europa Daylily but are usually fully closed by 9 P. M.

The various plants of the species *Hemerocallis fulva* and *H. aurantiaca* bloom in midsummer, when the temperatures are generally high. Of the daylilies which bloom in May and early June, the *H. Dumortierii* is also diurnal. Its flowers usually open after sunrise and they close about dark or soon thereafter, but sometimes the closing is delayed until 9 P. M. or later.

The nocturnal flowering is fully developed in the species *H. citrina,* which blooms during midsummer. The rule is that the sets of flowers open shortly before sunset, or at least before it is dark, remain widely open all night, and close the following morning soon after daybreak. During cool and cloudy weather the flowers remain open during a part of the forenoon or occasionally well into the afternoon.

In what may be called "extended flowering," the sets of flowers often remain open for as many as 30 to 50 hours. This habit is exemplified in the clon of *H. flava* observed by Parkinson and now commonly known as the Lemon Daylily or the Custard Lily. The writer has made observations on the flowering of this daylily at various hours of the day and night over a period of several years.

The Lemon Daylily is among the earliest of the daylilies to bloom in spring. As a rule during days of warmest weather the sets of flowers begin to open in the late afternoon, become fully or almost fully open about sundown or shortly before, and remain expanded during that night, the following day, and until about the following midnight. Cooler weather retards the opening of sets until the following forenoon or midday and if such temperatures continue the flowers may remain open through two periods of daylight and the intervening night. Apparently the sudden advent of cooler weather has a somewhat less retarding effect on the closing of the older set of flowers than it has on the opening of the next set in sequence. As a rule, during the warmer weather there are two sets of flowers open each evening from about 6 until near midnight, and but one set open during the hours of daylight. During periods of unusually low temperatures but sunny days, sets of flowers frequently remain fully open as long as 60 hours or occasionally as long as 72 hours. Thus a large well-established plant of the Lemon Daylily may have a period of blooming which covers several weeks, and during this entire period at least one set of flowers will be open at any hour of the day or the night.

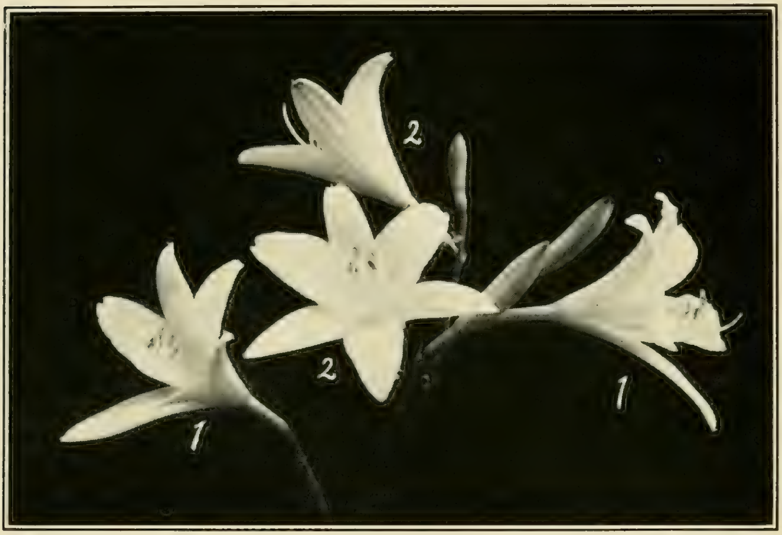

FIGURE 2. Flowers of the Lemon Daylily (*Hemerocallis flava*). A set of flowers (see 1) may remain open and in good condition for two periods of daylight, and thus overlap a newer set (see 2), which is for a time somewhat paler in color.

The extended flowering seen in the Lemon Daylily is a combination of both the nocturnal and the diurnal habits with also some further extension. Under certain temperatures the sets open in the late afternoon or evening almost as for the strictly nocturnal flowering, but the sets continue open throughout the following day and into the night beyond the hour when the flowers of the limited diurnal habit have fully closed.

For plants of the species *H. minor* observations indicate that the general rule is that two sets are open during most of the night, especially from sunset until midnight, and that there is one set open during the hours of daylight.

Several horticultural varieties which have the nocturnal *H. citrina* in their parentage are decidedly nocturnal but somewhat less so than *H. citrina.* Of these Citronella, Chrysolora, Calypso, Gold Standard, and Gold Imperial may be mentioned. Calypso, especially, has an excellent habit of growth, numerous scapes and flowers, and the flowers are of large size, full, and a delicate pale lemon-yellow. The flowers are fully open in the early evening and throughout the night but they are open as late as midday only when the temperatures are lower than usual or the day cloudy. Such a variety will provide attractive masses of flower color during the evening.

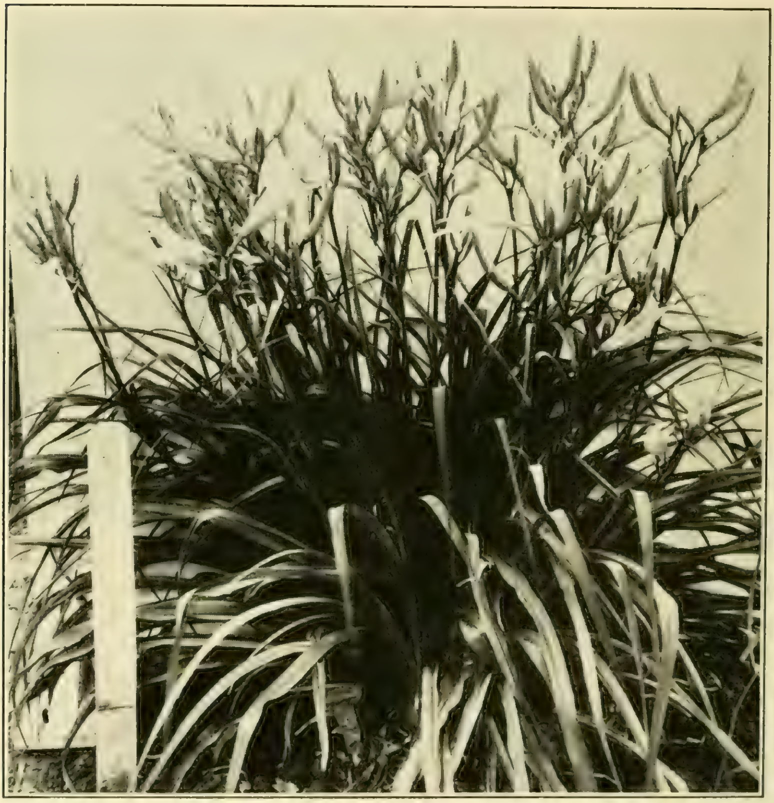

Figure 3. Plant of the Calypso Daylily. There are excellent foliage and numerous scapes and flowers, but the flowers are night-blooming. Photo taken at midday on a warm sunny day.

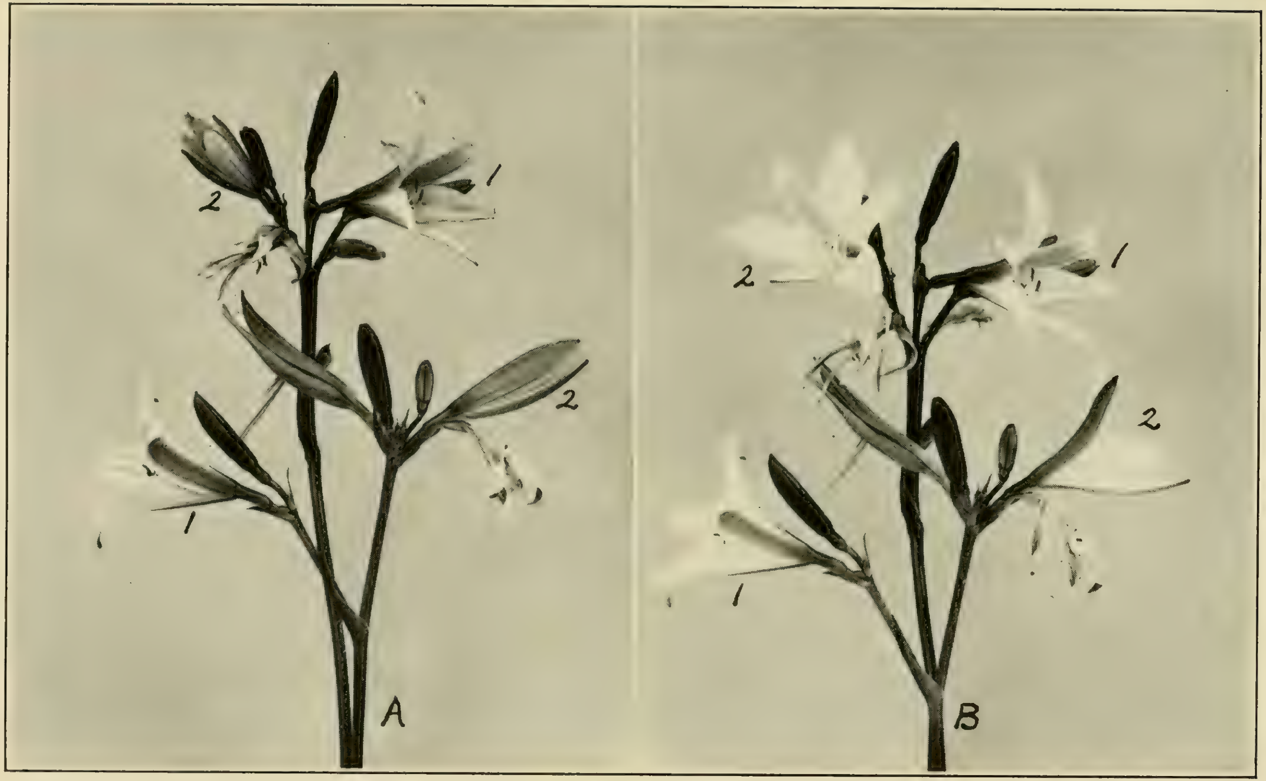

FIGURE 4. Flowers of the Gold Dust Daylily. *A*, at 10 A. M.; *B*, at 2 P. M. A set of older flowers (at 1) and a set of newer flowers (at 2) are open together during the afternoon.

There are several early-season clonal varieties such as Gold Dust, Sovereign, Estmere and Orangeman that are hybrids between the diurnal *H. Dumortierii* and some type with a more extended flowering. The general rule of behavior for these is that the flowers start to open after daylight, begin to close after dark, usually about 10, and are fully closed before the following dawn. When the weather is cool the opening may be delayed until near midday and the flowers may remain open throughout the second day, the entire period of anthesis covering as many as 48 hours. Then there may be two different sets of flowers open on a plant during the afternoon. In this case, the older flowers are for a time darker and more orange in color—a condition also to be observed for the flowers of the Lemon Daylily.

Many of the present horticultural varieties which bloom in summer are complex hybrids which have in their ancestry the *H. aurantiaca* and the *H. fulva,* which are diurnal, and the *H. Thunbergii,* which has somewhat extended flowering. The best of these have a good day-blooming habit. The flowers either open during the night or promptly at daylight and remain open until after dark and even as late as midnight.

The best sorts of daylilies for general garden use are those whose flowers hold form, color, and freshness throughout the hours of daylight and well into the night, even during days of high temperatures. Then the succession of different sets provides flowers day after day over the entire period of blooming. For many such varieties the flowers continue in good condition well into the night, a feature of value where daylilies are used for evening decoration.

It will add to the total display of color which daylilies make in the garden and to their value as cut flowers if new types can be obtained whose individual flowers habitually remain open and attractive for a period of several days. Possibly such types of daylilies will be developed in the future. In the breeding work with daylilies now in progress at The New York Botanical Garden, special study is made of the various hybrids in respect to any extension in the life of flowers.

A. B. STOUT.

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THE VEGETATIVE REPRODUCTION OF PRIMULAS

THE different habits of growth of the Primulas may be conveniently divided into groups; there are, of course, plants that seem to range from one group to another and there are some which it may be difficult to put into any definite section, but as the present grouping is based on features which are relative to propagation it will serve as a comparative guide for treatment.

First come the definitely stemmed type best illustrated by the Auriculas, the common Primroses, the forms and varieties of P. *obconica* and P. *malacoides*, and here it may be convenient to place such plants as the forms of P. *Sieboldii* as well as P. *Maclareni*, as the latter are credited with long creeping stolons. All of these may be propagated by stem cuttings. Recently a test batch of leaves of P. *obconica* produced quantities of roots from the end of the petiole when inserted in the fibre of a warm propagating frame.

Then there are the tufted types such as P. *cachemeriana*, P. *rosea*, P. *Normaniana*, some of the Capitatas, the many species of the Sikkimensis section and, if one is a good grower of them, the Candelabras, together with species like P. *involucrata* and its coloured form P. *yargongensis* (*Wardii*), and P. *elliptica*, all of which can be increased by separating out the crowns into individual plants.

Next come those best treated as biennials, such as P. *scotica*, P. *nutans*, the Muscarioides like P. *Littoniana*, and those Capitatas that exhaust themselves in seed production in their second year. For the average grower the Candelabras are often best treated as biennials.

The mat-forming types are distinctive but few, including P. *eucyclia* and P. *reptans*. These increase in size by rooting from the horizontal branches or shoots that hug the ground. *P. suffrutescens* almost comes in here as it will grow from branches that touch the soil as well as by pieces of stem.

Primula Forrestii, with its unique capability of growing by continual elongation of a single woody stem which is encased in the remains of many previous years' foliage, is of a type apart, but it is conceivable that were such a long stem to find itself in conditions where warm moist air caressed its lengthened axis, this would produce roots.

Of quite a different nature are those species which make a cluster of resting buds, often thickly dusted with meal, in the late autumn, and this most promising group for the garden includes the Petiolares, such as *P. Winteri* and *P. sonchifolia*, and the Nivalids, such as *P. macrophylla*, *P. sinoplantaginea*, *P. obliqua* with the promised glories of *P. aemula*, *P. muliensis*, *P. Agleniana* and *P. pulchella*.

Some of the Primulas of the type that in the autumn lay down fat buds in the axes of the leaves of the main rosette, such as *P. sonchifolia*, are seen to have these buds attached to the leaf in whose axis they have developed while roots emerge from the bud through the sheathing leaf base (the actual origin of these roots in the leaf is a phenomenon that has yet to be authenticated microscopically) in such a fashion as to permit of the buds, often when still attached to the leaf, being removed from the rosette and successfully established as individual plants. Consequently this desirable plant in particular may be increased safely and satisfactorily by separation of these axillary buds either in the late autumn or very early spring.

It has been noticed that seedlings of the Nivalids fade away if transplanted when root action is at all vigorous, so that they are best moved when definitely at rest after a spell of cold wintry weather, care being taken that in moving them the roots are not broken too extensively. If they can be grown well enough to make good fat buds they will

HEMEROCALLIS AURANTIACA AND HEMEROCALLIS AURANTIACA MAJOR

THE name *Hemerocallis aurantiaca* was bestowed by Baker in 1890 (*Gardeners' Chronicle*, vol. 68, p. 94) on a plant then growing in the Royal Botanic Gardens at Kew, England. But Baker's description of this plant does not correspond fully to any Day Lily now known—a point recently made by L. H. Bailey (*Gentes Herbarium*, vol. 2, p. 153, 1930). Hence the questions arise as to (1) what plant Baker did describe and (2) whether that plant is representative of a species which grows in the Orient.

It is known that Baker's plant was propagated and distributed and that it soon found its way into gardens and nurseries. It received rather favourable consideration in horticultural circles and it was used in hybridizations that gave new clons of value in garden culture. But at the present time somewhat distinct types of Day Lilies are being cultivated in Europe and America under the name *H. aurantiaca.* Some of these have flowers of orange colouring only; some have flowers with fulvous colouring in addition to the orange; and there are other differences to be noted. One of these types is without doubt the clon that was obtained by the repeated propagation of Baker's plant, but there seems to be no definite record which allows one to trace a continuous clonal pedigree back to that plant.

The writer has obtained and studied Day Lilies bearing the name *H. aurantiaca* from various sources in America, Europe and Japan. Some of these are of other types obviously incorrectly named. Even the double-flowered fulvous Kwanso Day Lily has been received under the name *H. aurantiaca.* One type, first obtained by the New York Botanical Garden in 1913, appears to be more widely distributed than the others and the various plants of it are identical and obviously they belong to one clon. Plants with the name *H. aurantiaca* obtained from the Royal Botanic Gardens at Kew appear to be of this clon. It is the opinion of the writer that this is the clon described by Baker as *H. aurantiaca*, and it was so described and illustrated in colour in *Addisonia* in 1929 (vol. 14, plate 461).

The plant is about 3 feet tall. The foliage is medium-coarse and evergreen in that it remains green and growing until winter ensues. The scapes are coarse, ascending, coarsely branched above, and there are nodes which bear conspicuous leaf-like bracts. The flowers are almost sessile or on short stout pedicels but the scape is distinctly branching. The open flower has a spread of about 5 inches. The segments are stiffly recurving, of firm texture, and those on the lower side of the flower are less recurving giving the appearance of being less widely open than flowers of other species excepting the *H. Dumortierii.* In the throat the colour of the flower is orange, but outside of this area the petals and sepals are delicately tinged with English red, and hence this type is to be classed as a fulvous Day Lily. The season of bloom is in July and the plant is fully hardy in the region about New York City.

The writer has made a careful comparison of this clon with the specimen of Baker's type plant now preserved in the herbarium at Kew. The colour of this specimen has faded, but in the size of the flower, in the shape and size of the petals and in the short thick pedicels of the flowers there is complete agreement.

The chief point of uncertainty in Baker's description of *H. aurantiaca* lies in his statement that the plant is most closely related to *H. Dumortierii.* This opinion was evidently based on general resemblance and especially on the fact that the flowers are "not opening widely". There are some grounds for such a comparison. Baker did not consider, and it is possible he did not recognize, the pale fulvous

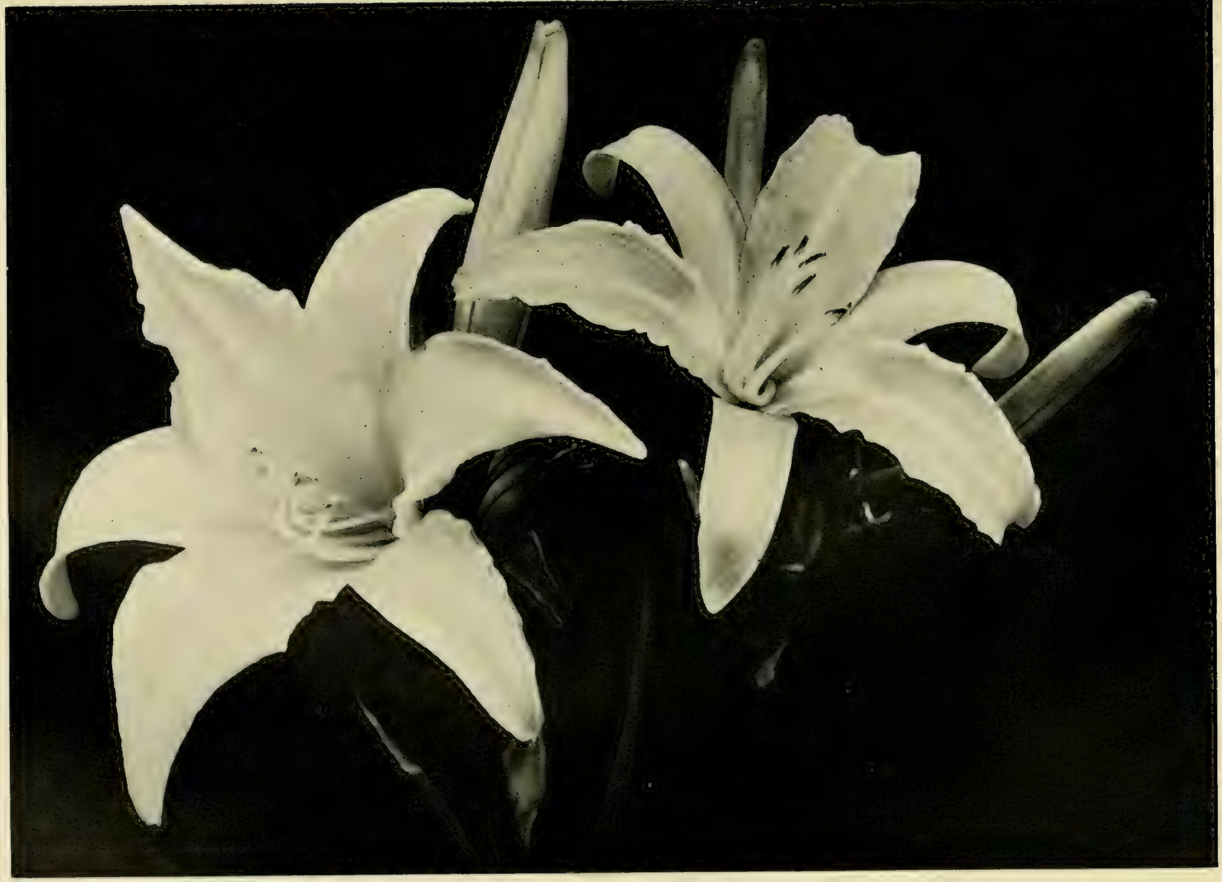

Fig. lxvii.—On left, HEMEROCALLIS AURANTIACA MAJOR; on right, HEMEROCALLIS AURANTIACA (p. 189)

Facing p. 184.

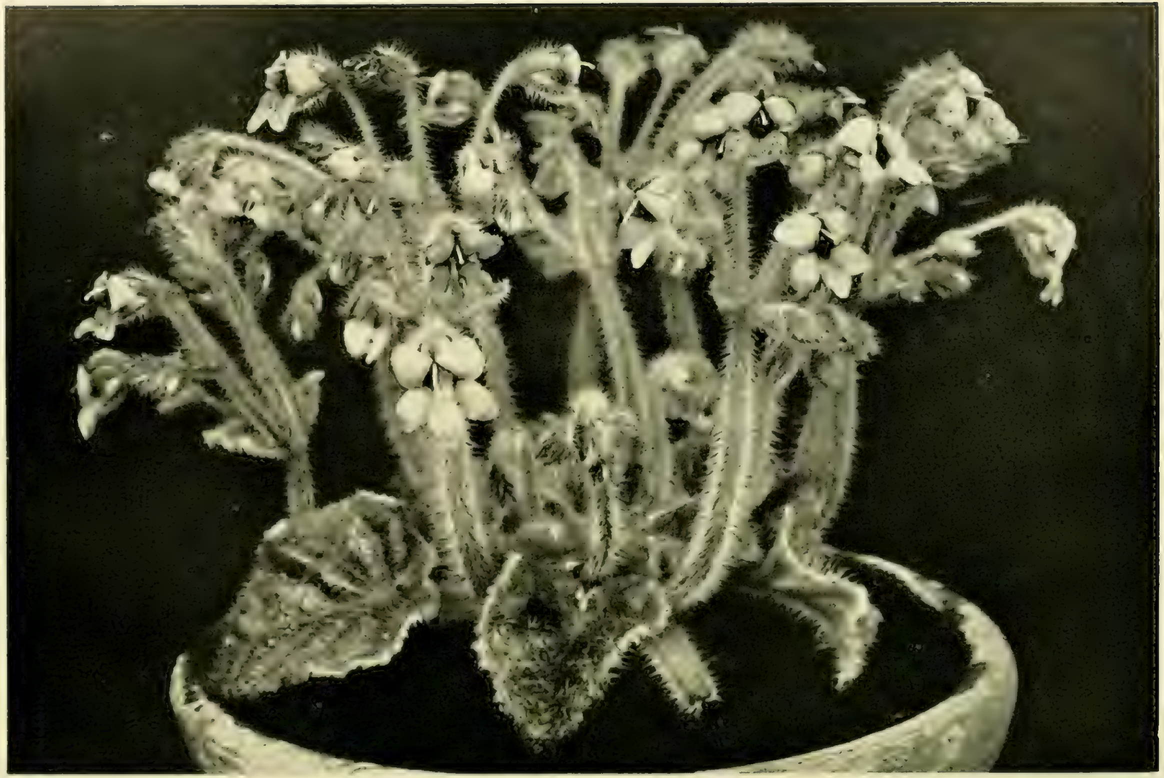

Fig. lxviii.—PETROCOSMEA PARRYORUM (p. 198) colouring of the flowers. Superficially the clon here described as *H. aurantiaca* could be viewed as somewhat like *H. Dumortierii.*

The clon of *H. aurantiaca* assembled by the writer is self-incompatible. Pollinations between the plants of this type obtained from many sources have given no seeds, which is the behaviour expected for plants of a clon derived from a self-incompatible plant. It may be noted that Baker did not describe capsules. The clon sets seeds readily to various cross-pollinations, and hybrids of such parentage are in the trade as horticultural varieties. The writer has grown many hybrids with *H. aurantiaca* as one parent and in some cases the second and third generations of the progeny have been grown. The evergreen habit of growth, the somewhat narrow and elongated petals, the flower shape and the fulvous colouring characteristic of the *H. aurantiaca* reappear in certain of the offspring, some of which are very similar to this parent. Some of the clons now being distributed as *H. aurantiaca* are no doubt hybrids between the type clon and other Day Lilies.

The *H. aurantiaca major* described by Baker in 1895 (*Gard. Chron.* vol. 78, p. 62) is very similar to *H. aurantiaca* in habits of growth and in season of flowering, but the flowers are much larger, more full, more widely spreading (see Fig. lxvii), and uniformly pale orange without any fulvous colouring. At New York and northward this Day Lily suffers from winter injury and does not thrive and bloom freely. The writer has never observed it in garden culture in the United States. It is recorded (*The Garden*, vol. 48, p. 400, 1895) that this plant appeared in cultivation in Japan and was probably a chance seedling of accidental hybridization. Various plants obtained from different sources in Europe and from cultivated stock in Japan are identical, and appear to belong to one clon, and some of those from Japan were obtained under the name "*Hemerocallis aurea*". But certain clons distributed under the name *H. aurantiaca major* have smaller flowers than the type and are evidently incorrectly named.

The description of *H. aurantiaca major* given by Dr. L. H. Bailey (*Gentes Herbarium*, vol. 2, p. 153, 1930) is of a fulvous Day Lily with flowers of only medium size that is frequent in gardens and hence evidently hardy in New York. This description and the accompanying figure 84 are certainly not of the *H. aurantiaca major* but for the clon of *H. aurantiaca*. Possibly Dr. Bailey has not known the large-flowered *H. aurantiaca major*.

The clons of *H. aurantiaca* and the *H. aurantiaca major* are very similar in habits of growth and in the "evergreen" character of the foliage, and in these respects the two are somewhat distinct from all other of the known species of Day Lilies.

The name *H. aurantiaca* was applied by the Japanese botanist Makino in the 3rd edition of the *Somoku-Dzusetsu* (vol. 6, plate 13, 1910) to a type of Day Lily mentioned and illustrated by a drawing in earlier editions under the name *H. flava* and it is stated that this plant is rather rare but grows wild in the region about Mt. Ibuki. But the descriptions and the comparisons are not critical and the writer can make no definite conclusions from the literature now available regarding the identity of the plant or its possible relationship to the *H. aurantiaca* described by Baker. The pen drawing of the flower is more like the flower of *H. aurantiaca major*. Plants said to be of wild stock collected at Mt. Ibuki have been obtained at the New York Botanical Garden through the courtesy of Mr. T. Suzuki of the Yokahama Nursery Company but these have not yet flowered. Various fulvous Day Lilies obtained from several sources in Japan closely approach the *H. aurantiaca* in the shape, size and colouring of flowers, but they are taller, the foliage is not evergreen and the capsules are different.

The botanical status of the plant named *H. aurantiaca* is a matter of uncertainty. It may be a plant of wild origin and be somewhat representative of a wild species, or it may be a hybrid with some type of *H. fulva* as one parent. The extension of the species name to include other plants of horticultural origin or plants of unknown origin from the Orient is unwarranted and the extension to wild types is not based on critical study. The *H. aurantiaca major* is said to be a seedling probably of accidental hybridization. At any rate there is no definite evidence that it is a member of a true botanical species or variety, although such may be the case.

The botanical names *H. aurantiaca* and *H. aurantiaca major* should, perhaps, be retained at least until a critical study of the wild Day Lilies of the Orient has been made.

The horticultural status of these two plants and of others with which they are frequently confused is clear. In each case a single plant was propagated as a clon. Each plant possessed, and still possesses, individual distinction which is of importance in horticulture and which it is necessary to recognize in horticulture. Confusion arises where specific and varietal names are given to such plants and where the attempt is made to extend these names to include more clons of horticultural origin and uncertain relationship.

The situation recited above regarding the identity and the status of the two Day Lilies in question also exists for other Day Lilies and for various plants of almost every type of plant in cultivation. Especially is this true for those whose individual character which often involves a hybrid or a polyploid nature is maintained by vegetative propagation.

It would seem that the interests of both horticulture and botanical nomenclature will best be served if (1) individual plants of perennials that are to be cultivated as horticultural clons are given horticultural names; if (2) plants that come into culture are not named as new species or assigned to old species unless there is definite knowledge that they are of wild origin and are fairly representative of a group of wild plants; and if (3) each perennial plant to be employed in horticulture or used in hybridization is maintained in a vegetatively propagated and pedigreed stock in at least some one botanical or horticultural garden.

A. B. Stout,
New York Botanical Garden.

[Fig. lxvii.]

LIQUIDAMBAR ORIENTALIS

MR. KNIGHT's note (Vol. IV. p. 161, 1932) to the effect that he had been successful in striking cuttings of this extremely rare tree interested me very much. I was delighted to find recently that similar success had attended the efforts of Mr. Wallis, the head-gardener at Woburn, who, some considerable time before Mr. Knight's note appeared in print, had obtained rooted cuttings and layers from the old tree at Woburn, described by me (*New Flora and Silva*, Vol. I. p. 173, 1929), to root after others had failed. Apparently this is not a very difficult matter if good half-ripened wood taken between July and September, according to the season, is used.

The method employed at Woburn is to take pieces about four inches in length, the base of the cutting being as near the old wood as possible; insert them in a pot which is placed under a bell-glass. In a comparatively short time the cuttings root freely. One cutting rooted in 1930 is now a vigorous plant 2½ feet high, which will be put out shortly.

Another but much slower method of propagation is to insert the ends of the cuttings in a bottle of water, the neck of the bottle being packed with moss. After about three months of this treatment the cuttings begin to show signs of rooting. Layers were obtained by pegging down some of the branches from near the base of the bole.

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VOL. XXXIV May, 1933 No. 401

JOURNAL
OF
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GUM-JUM OR GUM-TSOY: A FOOD FROM THE FLOWERS OF DAYLILIES[1]

The flowers of daylilies (*Hemerocallis*) are extensively used as a food in the Orient and in this use they are regarded as a delicacy, especially by the Chinese. They may be used fresh from a plant but they are employed chiefly in a dried form, which is easily handled in commerce and provides a supply at all times.

In certain areas in China and especially in Szechwan and along the Yangtze Valley, daylilies are grown as a crop plant for the yield of flowers, which are gathered shortly before they open. Evidently they are then easier to handle and probably those wilted and closed after the period of flowering have less substance. The flowers are dried, just how the writer has not learned, and then shipped in large bundles or hampers to some point where they are wrapped in paper for retail. Packages of pound and half-pound sizes are sold very generally in food shops under the names *gum-tsoy,* meaning golden vegetable, and *gum-jum,* meaning golden needles.

In culinary uses the flowers of daylilies are employed chiefly in soups, in various meat dishes, and with noodles. In preparation the basal end of the dried flowers, consisting of the ovary, is removed and the rest is cut into several segments. Enough water is added to the quantity desired to insure complete soaking, which soon makes the parts become soft, pliable, and somewhat gelatinous. In this condition the material is added to soups that are already cooked, and when the whole is brought to a boil again, a matter of a few minutes, the dish is ready to be served. To various dishes of meats and noodles the soaked flowers are added during the final stages of cooking, or the flowers may be cooked separately for a few minutes and added as a garnish—somewhat as mushrooms are often employed.

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[1] For most of the information here given the writer is indebted to Mr. F. H. Lewis, of the United States Appraiser's Office in New York.

To these various dishes the flowers add substance of individual consistency and they supply a distinct and pleasing flavor that is best appreciated and realized by the eating. Flowers that are freshly collected may be used in quite the same way, but the flavor is somewhat different from that when dried flowers are used.

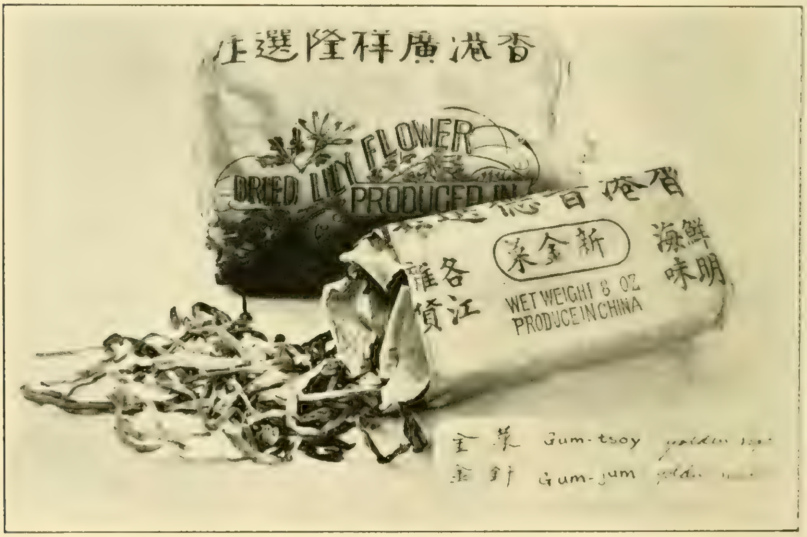

Figure 1. Pound and half-pound packages of gum-jum of the kinds imported for sale in New York City.

Dr. Albert N. Steward of the University of Nanking states that in his experience in east central China the flowers may be collected for use as food after they have closed and begun to wither. A recipe which he reports is the following:

"Fry small pieces of pork until they are brown, then add a little soy-bean oil and water. After cooking for an hour add the flowers and cook until they are tender. The addition of a little salt improves the flavor."

It is said that in China gum-jum is used by both rich and poor and that in many sections there is scarcely a family that does not use this article of food. Also, the product is used to some extent in other countries. During certain years as many as 4000 pounds have been brought from China into the port of New York City for consumption.

The following statement is quoted[2] from a publication called "The Principal Articles of Chinese Commerce," compiled by the Inspectorate General of Customs, Shanghai, 1930.

> "LILY FLOWERS, DRIED, (Chin-chen-ts'ai or Huang-hua-ts'ai). Lily flowers (dried) are the dried flowers of *Hemerocallis graminea* and of *Lilium bulbiferum*. Dr. Stuart says: 'They consist of inferior, tubular perianths of the unopened flower, enclosing six introrse stamens, with the three-celled, superior ovary, and simple stigma characteristic of liliaceous plants.' As they appear in the Chinese market, dried lily flowers are dark brownish yellow in colour, translucent, wrinkled, more or less twisted, in lengths of 4 or 5 inches, and covered with a whitish mould or bloom; they have an agreeable odour and a sweet, mucilaginous taste and are used by Chinese chiefly as a food, particularly as a relish with meat dishes. The Chinese also use them in medicine, considering them to be antifebrile and anodyne and to possess stimulating and intoxicating properties.
>
> "Lily flowers are produced chiefly in Szechwan and along the Yangtze Valley; they form a staple product of North Kiangsu and are usually packed for the market in large mat-covered bales weighing from 300 to 400 catties."

It may be noted that mention is here made of the fact that the dried flowers of daylilies are also utilized to some degree as a medicine in China.

The writer has not yet learned which, if any, type of daylily provides the best flowers for food. The dried flowers available for examination appear to be of a type of daylily (*Hemerocallis*) with narrow perianth-tube, narrow segments, and pale yellow coloring, and in the material examined to date there have been no flowers of *Lilium*. However, living plants obtained from

---

[2] For this reference the writer is indebted to Mr. Julean Arnold, Commercial Attaché, United States Department of Commerce, at Shanghai, China.

Szechwan[3] of the sort said to be cultivated there for its flowers have flowers of fulvous color and are to be classed as *Hemerocallis fulva.* In Japan the botanical name *Hemerocallis esculenta* has recently (Bot. Mag. Tokyo **38**: 28. 1925) been applied to a wild type of fulvous daylily.

A study[4] of the chemical analysis of the dried flowers of daylilies purchased in the market at Peking reports 2.77% fat, 5.35% ash, 11.42% protein, 8.48% crude fiber, all on dry basis, and a calculated carbohydrate percentage on a wet basis of 10.44%. According to this, the carbohydrate content in the dried flowers is high. The accompanying description is as follows: "Huang hua ts'ai, *Hemerocallis fulva,* are dried yellow flowers that are used as a food. The Filipino market name is bulaklak nang saging, because it is erroneously supposed to have some connection with the banana." In this report we note the Filipino name for this food and a different Chinese name from the usual gum-jum and gum-tsoy. The *Hemerocallis fulva* has flowers that are fulvous.

Possibly the flowers of any daylily are suitable for use as a food in the manner reported above.

A. B. Stout

AN EXHIBIT OF "PLANT FORMS IN ORNAMENT"

The New York Botanical Garden, in coöperation with the Brooklyn Botanic Garden and the Metropolitan Museum of Art, is holding an exhibition of "Plant Forms in Ornament," at the Metropolitan Museum, from May 8 to September 10, 1933. Objects of art containing plant forms are exhibited, together with such plants, flowers, specimens and illustrations as are available for comparison.

---

[3] These were obtained and sent to the Garden by Mr. W. P. Hsieh of the University of Chengtu through the arrangements made by Mr. Chien Pei while the latter was studying at the New York Botanical Garden in 1930.

[4] Sherman, Hartley E., & Wang, Tsan Ching. Chemical analysis of thirty-seven oriental foods. The Philippine Journal of Science **38**: 67–78. 1929.

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A. B. STOUT

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A DISPLAY GARDEN OF DAYLILIES

A collection of daylilies (*Hemerocallis*) has recently been planted in The New York Botanical Garden, which includes plants of the known species of this genus, more than 100 named horticultural clons, and numerous hybrids produced in experimental breeding at the Garden. The site of this special display is on the slope to the northwest of the Museum Building and in a direction slightly to the rear of it and it faces the main highway almost opposite the juncture of the entrance from Mosholu Parkway. Here this garden will enliven a long stretch of green lawn with masses of color during most of June, July, and August.

The accompanying figure shows the arrangement of this garden of daylilies. In the present planting there are six tiers of beds arranged in three radiating sections. Two additional sections and extensions to certain of the beds, indicated in the plot by broken lines, may be planted later. The lines of the tiers are slightly curved to conform to the curb-line of the highway which they face. The length of the beds in each section increases from the

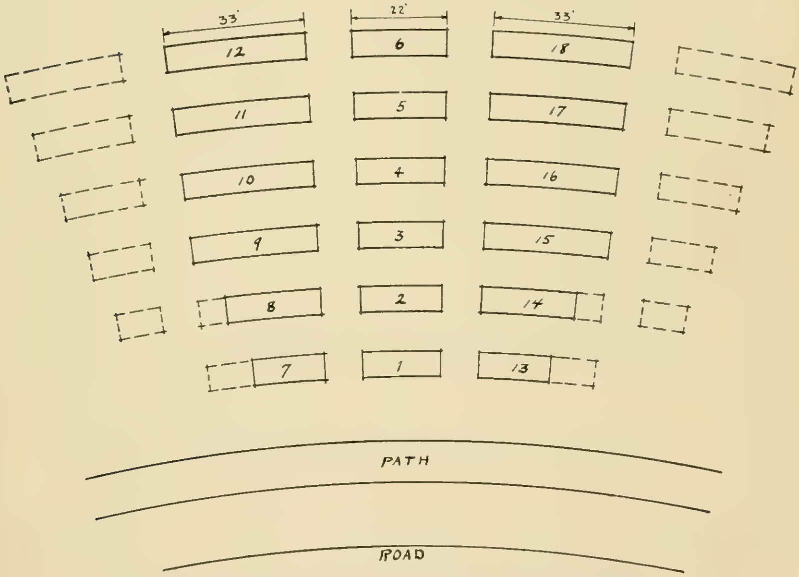

FIGURE 1. Plan of the display garden of daylilies.

front to the rear and the ends of the beds form broken radiating lines which are parts of radii of the concentric arcs which the lines of the tiers form. The straight lines are hence not parallel. This arrangement gives a compact grouping and allows definite arrangements for ready comparison, which are desired features in a display which is primarily educational. But the variations in the size of the beds and the alignments combine to give a more pleasing effect than when the same number of square or rectangular beds are evenly spaced. Also the plan conforms to the contours of the site, which slopes gently from rear to the front and from the sides to the line of the central row, which forms the axis of the garden.

The central section of six beds (nos. 1–6) is planted with species and botanical varieties. One lateral section (beds 7 to 12) contains horticultural clons and the other section now planted (beds 13 to 18) contains hybrid seedlings. In the grouping of these plants consideration has been given to landscape effects and color values. The low-growing early-flowering plants are in the front tier of beds and the taller and late-flowering sorts are in the rear beds. In the long dimension of each bed there are three ranks of plants with the lowest in the front. There is also grouping according to color; the three beds at the rear are planted chiefly with fulvous daylilies. As the plants become established and reach full stature, various features of the arrangement will be studied and changes made to obtain the most effective grouping within each bed and for the collection as a whole. In most cases large clumps of plants have been used which provide this year masses of foliage and flowers and which rather fill the various beds.

The species represented are *Hemerocallis flava, H. fulva, H. minor, H. Dumortierii, H. Middendorffii, H. aurantiaca, H. Thunbergii, H. citrina, H. Forrestii, H. nana, H. plicata,* and *H. multiflora.* Besides the types first brought into cultivation there are for several species other types obtained directly from China and Japan, which present variations within the species. For *Hemerocallis fulva* there are wild plants from several widely separated localities, which include the varieties *H. fulva longituba* and *H. fulva rosea.* There are also in considerable number plants raised from seed collected from wild plants which do not conform closely to any of the named species.

The horticultural clons are mostly of hybrid origin. In a few cases these plants were given names of the rank of true botanical varieties. The list of horticultural clons now planted in this collection is as follows: Ajax, Amaryllis, Apricot, Aureole, A. H. Austin, Bardeley, Baroni, Bay State, Anna Betscher, Bijou, E. A. Bowles, Burbank, Byng of Vimy, Calypso, Cissy Giuseppe (Chocolate Soldier), Cinnabar, Citronella, Corona, J. A. Crawford, Cressida, Dawn, Dwarf Yellow, Eldorado, Erica, Estmere, Flamid, Florham, Framingham, George Yeld, Golconda, Gold Dust, Gold Imperial, Gold Standard, Golden Bell, Golden Dream, Goldeni, Golden West, Gypsy, Harvest Moon, Lady Fermoy Hesketh, Hippeastrum, Hybrida Semperflorens, Hyperion, Imperator, B. Ladham, Lemon King, Lemon Queen, Lemona, Lovett's Lemon, Lovett's Orange, Luteola, Luteola Grandiflora, Luteola Major, Mandarin, Mrs. James R. Mann, Marigold, Middendorffiana, Mikado, Miranda, Modesty, Mulleri, Nocerensis, Ochroleuca, Ophir, Orange, Orange Gem, Orange Glow, Orangeman, Orange Vase, Parthenope, Gladys Perry, Iris Perry, Marcus Perry, Margaret Perry, Mrs. Perry, Perry's Pigmy, Thelma Perry, Queen Mary, Queen of May, Radiant, Dr. Regal, Revenge, Rose Queen, Royal, Shirley, Sirius, Sir Michael Foster, Soudan, Sovereign, Sunny West, Sunset, Tangerine, The Gem, Taplow Yellow, Vesta, Viscountess Byng, Vomerensis, Wau-Bun, Winsome, Donald Wyman, Mrs. W. H. Wyman, and Yellow Hammer. The newly named varieties Taruga, Charmaine, and Theron are for the present to be seen in the experimental plots but they will soon be represented in the display garden.

The cultivated clons which belong in the species *Hemerocallis fulva* are planted in bed 12 and these include plants of the Europa Daylily obtained from several different countries, the clon called "The Saracen" which appears to be identical with the Europa Daylily, the Maculata Daylily, and the double-flowered clons known as Kwanso, Flore Pleno and Variegated. All of these are triploid and obviously horticultural types. There is also the *H. fulva* clon Cypriani.

The section devoted to hybrid seedlings produced at the Botanical Garden includes (1) first-generation hybrids of many combinations between species, (2) typical plants of later generations which illustrate the ranges of variation for various hybrid progenies, and (3) many hybrids that are ranked as excellent and of possible merit for culture as garden plants. One bed (no. 17) is filled with hybrids that have *Hemerocallis multiflora* as one parent. Bed no. 18 is planted with hybrids having some type of *H. fulva* in the parentage and which have a robust habit of growth and mostly flowers in fulvous colors. In general this section demonstrates in living plants the results that are obtained in hybridizing daylilies and the effectiveness of continued selective breeding in the development of new types of daylilies of value in floriculture.

The assemblage of species, named varieties, and wild plants in this collection of daylilies has been in active progress since 1921. A few plants have been purchased, but only from three nursery firms in Europe. All other plants have been donated to the Garden.

The nursery firms and growers who list plants for sale that have contributed living plants, mostly species and clons of the types in cultivation, are as follows: Amos Perry, Enfield, England; Bay State Nurseries, North Abington, Massachusetts; Bristol Nurseries, Bristol, Connecticut; Carl Purdy, Ukiah, California; Fairmont Iris Gardens, Lowell, Massachusetts; John Lewis Childs, Flowerfield, Long Island, New York; Farr Nursery Co., Weiser Park, Pennsylvania; Franklin Mead, Fort Wayne, Indiana; Lovett's Nursery, Inc., Little Silver, New Jersey; Midwest Gardens, Washington, Nebraska; Mt. Desert Nurseries, Bar Harbor, Maine; R. and J. Farquhar Co., Boston, Massachusetts; Willy Müller, Hortus Nucerensis, Naples, Italy; and Yokahama Nursery Co., Yokahama, Japan.

Botanical gardens that have supplied plants and in some cases also seeds of species include the following: Royal Botanic Gardens, Kew, England; Royal Botanic Gardens, Edinburgh, Scotland; The Gardens of the Royal Horticultural Society at Wisley, England;[1] Botanic Garden of the Université de Strasbourg, France; Botanical Garden of the U. S. S. R. Academy of Sciences, Leningrad, U. S. S. R.; Botanical Institute, Tokyo Imperial University, Tokyo, Japan; and Botanic Garden, Harvard University, Cambridge, Massachusetts.

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[1] Various of the plants thus obtained were sent by permission of nursery firms that had supplied the plants for trial and display at Wisley. Several new varieties introduced by Barr and Sons were thus obtained.

Various persons not connected with the firms and institutions mentioned above have supplied plants or seeds or both plants and seeds which they collected or obtained in various sections of Japan, China, and Manchuria. Of these mention should be made of the following: Mr. T. Susa, Director Aomori Agricultural Experiment Station, Kuroishi, Aomoriken, Japan; Dr. Albert N. Steward, University of Nanking, Nanking, China; Mr. H. H. White, formerly of the Presbyterian Missions; Professor Y. Kikazaki, Saitama Agricultural Experiment Station, Urawa, Japan; Mr. W. P. Hsieh, Chengtu University, Chengtu, Szechuen, China; Dr. Arthur Jacot, Shantung Christian University, Tsinan, China; and Mr. A. D. Woeikoff, Director, Echo Experimental Farm, Tieh-ling-ho, Manchuria.

To all these and to various persons connected with the firms and institutions mentioned the writer is personally much indebted for the help and assistance which has made this collection of living plants of *Hemerocallis* possible. It is without doubt the most complete collection of these plants thus far assembled.

Gardeners may visit this garden of daylilies, observe and compare the different species and the named horticultural clons, and make their own decisions regarding the merits of the daylilies and the selection of those that are most desirable for culture.

A. B. STOUT.

"CURE IT WITH A GARDEN"[1]

This book, replete as it is with information and advice for the novice in gardening, and with valuable suggestions for the more experienced, will be chiefly regarded by some readers as a gem of English literature. Not since the appearance of Charles Dudley

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[1] Robbins, Leonard H. Cure it with a garden. Pp. 175. Houghton Mifflin Company, Boston and New York. 1933.

Warner's "My Summer in a Garden," have we had anything at all like it, this resemblance being in the humorous features of the two books. Humor is perhaps Mr. Robbins' predominating sense, and it is a humor of rare quality. We doubt if in all his writings there occurs any suggestion that can have caused a heartache. His humor is genial and kindly and the subject of his animadversions can only smile with him. We can even imagine the plants themselves chuckling, if they could read his comments on their frailties, shortcomings, and general waywardness. As the gardener enjoys the fun of the situations depicted, he absorbs knowledge that is to save him from mistakes which he recognizes as his very own.

Mr. Robbins' opening chapter, in which he compares the gardening undertaking with a stock market adventure, is perfect in every detail and brings the gardener out a winner.

Nowhere else have we seen the charm of our flowers so fascinatingly depicted. As we read, we wonder why we have not appreciated our favorites more highly, and we drop the book and hasten out to look at our spring beauties, trying to see something in them that we have not seen before.

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We shall be greatly mistaken if this book does not find a place on the "ready reference" shelf of very many country homes.

H. H. RUSBY.

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THE NEW YORK BOTANICAL GARDEN
BRONX PARK, NEW YORK, N. Y.

VOL. XXXV JANUARY, 1934 No. 409

JOURNAL
OF
THE NEW YORK BOTANICAL GARDEN

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A. B. STOUT

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CAROL H. WOODWARD

NOTES, NEWS, AND COMMENT

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DWARF DAYLILIES

It has been about twenty years since the plant collector George Forrest discovered certain daylilies in southwestern China which in the natural habitat grow less than a foot tall. These appear to be distinct from and more dwarf than the smallest of the previously known species, such as *Hemerocallis Dumortierii, H. Middendorffii,* and *H. minor.*

From the material collected by Forrest three new species were described under the names *H. Forrestii, H. nana,* and *H. plicata.* Plants of these were soon brought into cultivation in England and later in America. It seems that these daylilies have not thrived in these countries. Apparently they are not fully hardy or the proper conditions for successful culture have not been supplied. Yet these dwarf types of daylilies should be of value for culture and for use in hybridizing with other types for the development of dwarf clons that are hardy and adapted to general culture.

Hemerocallis nana. The *H. nana* is clearly a well-defined type of dwarf stature. A photograph of a wild plant in its natural habitat was shown in 1916 (Jour. Roy. Hort. Soc. **42**: *f. 12*), a description appeared in 1917 (Notes Bot. Gard. Edinburgh **10**: 39), and later there was published an illustration in color (Bot. Mag. **148**: *pl. 8968.* 1923). A typical plant of this species received from the Gardens of the Royal Horticultural Society in England and grown at The New York Botanical Garden is shown in FIGURE 1.

The plants of *H. nana* grow compactly in the crown with short and almost erect branches. Some of the roots become somewhat enlarged and fleshy but, as far as the writer has observed, the fleshy part is at the end of a root and at some distance from the crown. For plants in culture the leaves may be much as 15

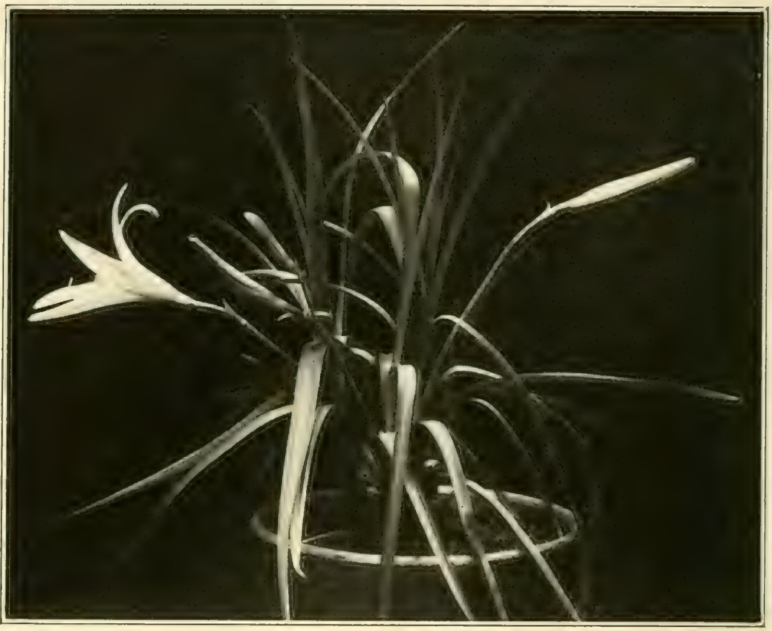

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FIGURE 1. A plant of *Hemerocallis nana* obtained from the Royal Horticultural Society and grown at The New York Botanical Garden. The six-inch pot gives a measure of the dwarf stature of the plant.

inches long, expanded rather than plicate, and longer than the scapes. The scapes are slender, bending outward, and usually they bear one flower. When there is more than one flower the scape is branched. The bracts are inconspicuous and often there will be two to a scape, even though there is but one flower. The flowers may have a spread of three or more inches; the segments are rather narrow; the tube short and not sharply defined; the color on the inner face is a clear orange, but on the reverse there may be shades of reddish-brown.

The photograph taken by Forrest and his herbarium material show plants with rather sparse foliage and short scapes. The same is true of specimens collected by J. F. Rock (his Nos. 5231 and 9593) collected in 1922 and 1923 in Yunnan, which appear to be *H. nana*. (See FIGURE 2.) In the herbarium specimens the leaves seem decidedly plicate, the tips of the leaves are often broken, and in the specimen collected by Forrest (FIGURE 2) which the writer has seen the tips of the leaves were evidently removed by some animal with the result that they appear to be shorter than the scapes. In comparison with these, the plants of this species grown in pots at The New York Botanical Garden (see FIGURE 1) are larger with longer and broader leaves that are not plicate. It is to be expected that the plants which are grown in gardens or in pot culture will be taller and more lush than those plants which grow in the wild and especially when they are on poor soil in dry and rocky habitats.

This species somewhat resembles the *H. Dumortierii* in habits of growth and character of the flowers, but is less robust, the bracts are less conspicuous, and the scapes are, when more than one-flowered, decidedly branched.

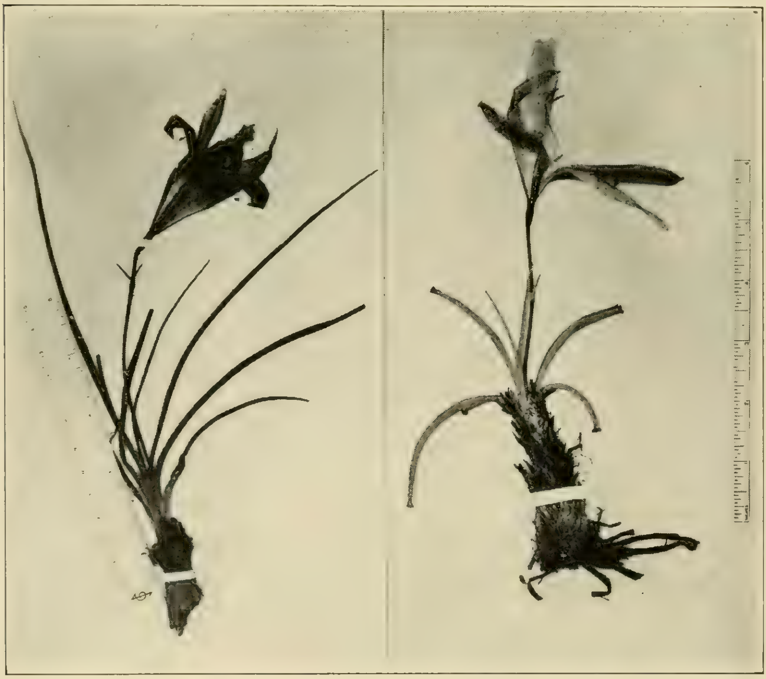


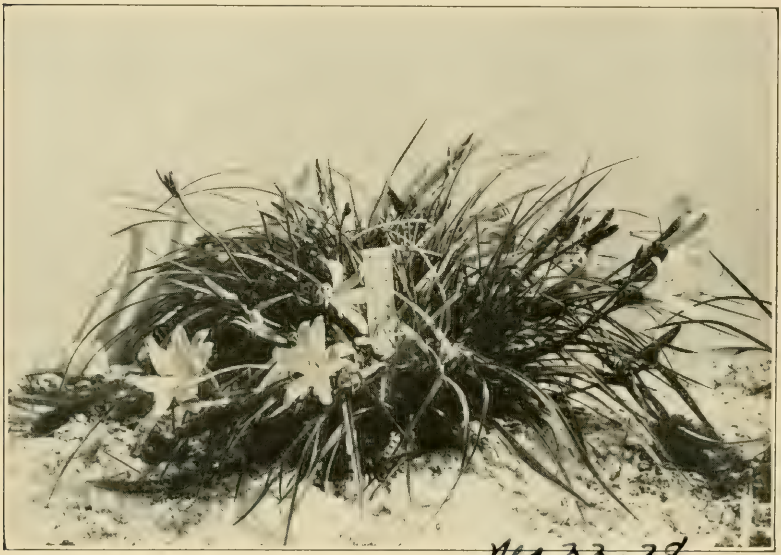
FIGURE 2. At left: Photograph of an herbarium specimen evidently of *Hemerocallis nana* collected in 1922 by J. F. Rock (No. 5231) on the eastern slope of the Likiang Snow Range, Yangtze watershed, Yunnan, China. At right: Photograph of an herbarium specimen of *H. nana* collected by George Forrest (No. 20424) in 1911 in northeast Yunnan, China.

Hemerocallis plicata. The *H. plicata* was first described by Stapf (Bot. Mag. **148**: *pl. 8968.* 1923) as different from *H. nana* chiefly in having usually folded or plicate leaves and a more branched inflorescence. An herbarium number (Mengtse, Henry 9497), a sheet of which is now at The New York Botanical Garden, was cited in the original description as belonging to this species. This specimen shows a branched scape about 10 inches long bearing as many as four flowers and extending above the foliage. Living plants obtained in 1929 from Great Britain as *Hemerocallis plicata* were evidently *H. nana,* for the scapes were shorter than the leaves and only one- or two-flowered. Later, in 1933, plants of this specific name, also from stock in cultivation in Great Britain, had slender scapes 16 inches long that extended well above the leaves and bore as many as eight flowers in a much-branched inflorescence. The flowers had a faint but distinct halo of fulvous color in the face of both petals or sepals. The capsules produced were decidedly three-sided and tapered to an acute point. It is not clear what the valid distinctions of this so-called species are.

Hemerocallis Forrestii. This species was first described in 1912 (Notes Roy. Bot. Gard. Edinburgh **5**: 298. 1912) from material collected by Forrest in 1906 on the eastern flank of the Lichiang Range in China. The first description stated that the plants grew to a height of 18 inches and had flowers reddish-orange in color, and that the species is to be regarded as related to the *H. fulva.* There has, however, been no trace of fulvous coloring in the flowers of plants received as *H. Forrestii* at The New York Botanical Garden, a typical plant of which was illustrated in color in *Addisonia* (**15**: *pl. 381*). As far as the writer can judge, this species is more robust than the *H. nana* and the scapes are usually several-flowered.

The so-called H. fulva angustifolia. A daylily that was considered to be a dwarf variety of *H. fulva* was described by Baker in 1871 (Jour. Linn. Soc. **11**: 359). This plant was described as having scapes scarcely a foot tall and leaves only 12 to 18 inches long. The description was based on herbarium specimens collected at Khasia, India, from Guriev near the the northwestern side of the Caspian Sea, and from Karabagh in Caucasia. There is no definite evidence that the color of the flowers was fulvous and it seems very probable that these collections are of plants very closely related to the *H. nana.* No living plants or seeds of the daylilies in these localities have, apparently, ever reached Europe or America for culture.

A Dwarf Clon Resembling Hemerocallis Dumortierii. A plant which is indeed dwarf was received by the writer several years ago under the name *Hemerocallis graminea* but this is either a somewhat aberrant plant of *H. Dumortierii* or a hybrid with this species as one parent. Figure 3 shows the habit of this plant and the six-inch rule set upright in the plant shows the dwarf size. The foliage is slender and about 15 inches long. The scapes are about a foot long, slender, drooping and usually the 2 or 3 flowers of a scape are in a compact cluster. The plant closely resembles *H. Dumortierii* but is more dwarf, and the roots are less fleshy than the type commonly seen in culture or obtained from the wild. The plant shown in Figure 3 has been grown for eight years without division.



Neg 33-38

Figure 3. A plant standing less than a foot tall, as is indicated by the six-inch rule. Apparently a dwarf type of *H. Dumortierii.*

This plant has been hybridized with various daylilies and especially with *H. nana* and the seedlings are now being grown in the hope that desirable dwarf plants will be obtained.

face of the flowers but also on the back of the petals. These plants set no seed to any of the many pollinations that were made. The seedling shown in FIGURE 4 is being propagated under the name NADA daylily.

Numerous seedlings from various hybridizations involving plants of *H. nana, H. plicata,* and *H. Forrestii* are being grown which have not yet flowered.

Dwarf plants have frequently appeared among the seedling daylilies reared from parents that are semi-dwarf or even robust. Some of these, which are now about ten years old, have small slender leaves less than a foot long but no flowers have been produced. Others that stand about 18 inches tall are rather attractive plants and are perhaps worthy of culture provided better seedlings are not obtained in this semi-dwarf stature. Several such plants are now being propagated.

Conclusion: The wild dwarf daylilies, and especially plants of *Hemerocallis nana,* discovered in southwestern China, are without doubt worthy of a more general trial in gardens of America. These daylilies should, it would seem, be welcome additions to the rock garden. Surely in various parts in the United States conditions will be suitable for their culture. Daylilies of dwarf stature also exist as variants in the species *H. Dumortierii* and *H. minor* and they also appear among seedlings of more robust parents. Some of these are worthy of garden culture.

These dwarf daylilies should also be of value for further hybridization and selective breeding in the development of dwarf or semi-dwarf clons comparable in flowering habits and flower colors to the best of the more robust clons now available for garden culture. A beginning has already been made in the production of such clons.

A. B. STOUT.

NATIVE IRIS NOTES—I

I. On the Relative Vitality of Louisiana Iris

In one of the temporary plantations of Gulf State irises at the Botanical Garden, differences in the vitality of various specimens were very evident during the past season.

An opportunity was afforded to observe the relative growth of the plants over a period of two years in a temporary nursery where the plants were set out in rows as they were received from the field in the spring of 1931. The rootstocks were planted in rows, so many of each accession number being preceded by a record label. The nursery rows were separated by foot-paths and there was considerable walking between the rows of plants. The plants grew vigorously. The majority, moreover, remained within their intended bounds. However, notwithstanding the tramping in the paths, the plants of several species grew with such vigor that the rootstocks not only mingled densely in their own allotted space, but grew across the paths on either side and mingled so intimately with those of their neighbors that it was in many cases impossible to separate the two with confidence. The worst "sinners" so to speak were: *Iris vinicolor, I. oenantha, I. fourchiana,* and some varieties of *Iris giganticaerulea.*

II. Autumn Flowering of Louisiana Iris

Some recent performances among the Louisiana irises may give heart to those who are seeking for a race of autumn-flowering irises. In one of our plantations of irises set out with plants from the temporary nursery referred to above, in the summer of 1932, an interesting phenomenon was observed. About a month after the regular flowering season—June—the plants of several numbers of the irises collected prior to 1931 began to flower. From the first week in August to the last week in September, normal flower-stalks two and a half to three and a half feet tall appeared. With one exception they were pink- or red-flowered species. Some of the stalks bore as many as nine flowers, and many of the flowers were exceptionally fine. Will these plants repeat this routine next year? Unfortunately the late-flowering period did not permit of the ripening of the seeds. The plants under the following Garden accession numbers flowered in the two autumn months: Numbers

62751, 62753, 62761, 62791, 62878, 62879, 62913, 62924, 62925, 62945, 62961, 62997, 62999. Iris-growers who may see this note and have received plants of the numbers cited here may be interested in watching their autumn behavior. We have no assurance that these plants will repeat their fall program next year, but we shall await the time with interest.

John K. Small.

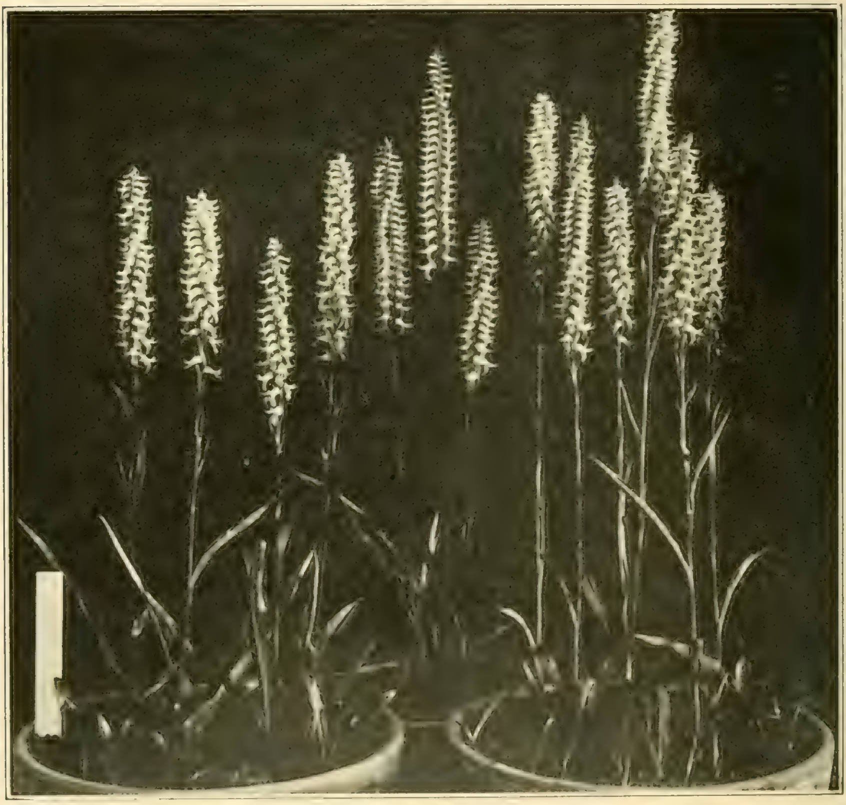


Figure 1. Specimens of *Ibidium odoratum* which flowered at The New York Botanical Garden last fall. Forty-two suckers were produced by these 14 plants.

ORNAMENTAL LADIES'-TRESSES

Last year (Jour. N. Y. Bot. Gard. 34: 106–108), I published a note on "Our Largest Ladies'-Tresses," *Ibidium odoratum.* The subject of the note was a young plant brought to the Garden from New Orleans, La. It flowered last fall and made three "suckers" which were transferred to a pan. In the meantime Mr. J. B. Wallace, of New Orleans, sent twelve young plants to the Garden. These were set out, six each in two large pans. Eleven of the new plants grew and flowered along with the three descendants of the single plant that flowered in the fall of 1932. The plants began to open their flowers the first week in September and continued to flower until the first week in November (FIGURE 1).

In addition to the long flowering-season this autumn, two other interesting features were evident. I.—Seven of the flowering-spikes had a clockwise twist, while seven others had a counter clockwise twist. II.—The fourteen separate plants have produced forty-two "suckers." This indicates forty-two flower-spikes for next fall's growth, or three new plants apiece for each plant now flowering, just as the single plant last fall made three new plants for this year's growth. For a plant accustomed to the normal soil and fresh air of a southern swamp this plant shows remarkable vigor when grown under glass in the North. Several of the flower-stalks now measure more than two feet in height. One of the flower-spikes is nine inches long as against the one six inches long referred to in the note mentioned at the beginning of this note.

JOHN K. SMALL.

CONFERENCE NOTES FOR DECEMBER

A conference of the Scientific Staff and Registered Students of the Garden was held on the afternoon of December 13.

Dr. Marshall A. Howe discussed "*Riccia* in the Galapagos Islands," with reference to a considerable number of specimens of this genus collected on these islands in 1932 by Mr. John Thomas Howell, botanist of the Templeton Crocker Expedition of the California Academy of Sciences. Although short lists of the Hepaticae of the Galapagos Islands have been published, the only reference to a *Riccia* occurs in Dr. B. L. Robinson's "Flora of the Galapagos Islands" in which Professor Alexander W. Evans mentions a specimen from Chatham Island as "sterile and indeterminable." In the material collected by Mr. Howell, three species are represented. Two, closely allied to West Indian species but distinguishable, are being proposed as new. One of them, somewhat variable, is represented by eleven specimens from five islands: the other is based on a single collection on Chatham Island. A few specimens of Anthocerotaceae from the Galapagos Islands and Cocos Island and species of *Riccia* collected by the Templeton Crocker Expedition in Costa Rica and Lower California and outlying islands were also discussed.

Under the title of "Mycological Notes," Dr. Fred J. Seaver directed attention to a number of interesting fungi which have recently come to hand. Among these was a rare phalloid, *Anthurus borealis,* collected by Dr. A. B. Stout in a spent hot frame in the Botanical Garden, a species described by Dr. E. A. Burt in 1894. While it has been collected occasionally in the eastern United States, it belongs to a genus which is essentially tropical. There is only one other record of its having been collected in The New York Botanical Garden. In October, 1919, Mr. Kenneth R. Boynton made a collection of this species in a gladiolus bed as noted by Dr. Murrill in *Mycologia* for 1920.

This was contrasted with another rare phalloid, *Colus javanicus,* which was collected over several seasons in a limited area in The New York Botanical Garden and is known from only one other locality in continental North America. An account of this was published in *Mycologia* (23: 83. 1931). While it is recognized that many of the fungi are cosmopolitan in the same latitude throughout the world, the tropical species are thought to be rather exclusive. The occurrence of two supposedly tropical forms in The New York Botanical Garden is therefore of unusual interest.

Dr. Seaver devoted most of his time to a review of his work on North American cup-fungi, directing attention to a number of interesting forms and additional information on recorded forms which has been accumulated since the publication of his first volume, North American Cup-fungi (Operculates), in December, 1928. The talk was illustrated with numerous photographs and sketches.

A. B. Stout,
Secretary of the Conference.

A GLANCE AT CURRENT LITERATURE[1]

In a report of recent studies in plant propagation conducted by the Agricultural Experiment Station at Cornell University, L. C. Chadwick describes the influence of chemicals, of the medium, and of the position of the basal cut on the rooting of evergreen and deciduous cuttings. Valuable tables and diagrams relating to a large number of different species and the manner of treating them are given in the paper, which has been issued as *Bulletin 571.*

* * * *

Readers of the *Gardeners' Chronicle* for December 9 will be envious of Lady Londonderry, in whose garden at Mt. Stewart, Ireland, is a large bed of *Meconopsis violacea.* The plants, the first of which were found in Upper Burma by F. Kingdon Ward, are growing three and a half feet high and blooming with an abundance of large violet-colored flowers with orange anthers. They are reported to be seeding themselves freely, and seem successfully established in their new home.

* * * *

The 1933 *Lily Year Book* published by the Royal Horticultural Society of London, contains an article by Dr. A. B. Stout, of The New York Botanical Garden, in which are summed up the present results of his work in the study of sterility in lilies. He describes different types of sterility and lists cases of interspecific sterility and fertility among lilies. The paper is followed by a report of the discussion which took place when it was read at a London meeting.

* * * *

"When Winter Comes to the Garden" is the subject of an interesting and practical article in *Horticulture* for November 15. In the same issue, John C. Wister describes certain notable gardens of the East under the title "Where the Country's Finest Lilacs Grow."

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[1] All publications mentioned here—and many others—are to be found in the Library of The New York Botanical Garden, in the Museum Building.

* * * *

A brief story of an unusually interesting herb garden is told among other garden tales in the November *Bulletin of the Garden Club of America.* Dorothy E. Pletcher also writes of herb gardens in the December *Nature Magazine.*

* * * *

The Orchid Review for November includes "Sick Orchids: Some Causes and Cures" by B. Hills, of Exbury, a grower with thirty years of practical experience in raising orchids.

* * * *

An all-American selection of annuals described in the December 1 issue of *Horticulture* includes a giant Scabiosa with curled petals, Pink Gem variety of *Petunia nana compacta,* the annual chrysanthemum known as Eldorado, the aster Los Angeles, and Hunnemannia Sunlight.

* * * *

How foresters are growing trees on the mid-western prairies, where nature for thousands of years has failed, is told by Clyde M. Brundy in the December number of *American Forests.*

* * * *

New terms that are becoming accepted in genetics, but which have not yet appeared in any dictionaries, are being published in a glossary on the inside back cover of the *Journal of Heredity,* beginning with the October number.

* * * *

The fourth number of *Brittonia,* a series of botanical papers, principally systematic and geographical, being published by The New York Botanical Garden, appeared last month. It contains descriptions and discussions by A. C. Seward, of Cambridge, England, and by E. D. Merrill and Albert C. Smith, of The New York Botanical Garden.

* * * *

New books lately acquired by the Botanical Garden Library include a number of volumes on gardening and entomology. H. Stuart Ortloff gives special attention to design in his work on "In-formal Gardens." "The Principles of Plant Culture" is the subject of E. S. Goff. Edward Oliver Essig has written "A History of Entomology," K. M. Smith "Agricultural Entomology," and John Percival "Agricultural Bacteriology," all of which are now in the Library. Volume III of The Ferns, in the Cambridge Botanical Handbooks, deals with Leptosporangiate ferns. F. O. Bower is the author.

Carol H. Woodward.

NOTES, NEWS, AND COMMENT

At the annual meetings held in Cambridge, Massachusetts, in the last week of December, Dr. E. D. Merrill was elected President of the Botanical Society of America, and Dr. B. O. Dodge was elected Vice-president of the American Association for the Advancement of Science and Chairman of its Section G (Botany). Members of the Botanical Garden staff attending the meetings were, in addition to Dr. Dodge, Dr. Marshall A. Howe, who presented a paper on "A marine-algal reef in the mountains of California"; Dr. H. A. Gleason, who continues as Treasurer of the Botanical Society of America; Dr. F. J. Seaver, who continues as Managing Editor and Editor-in-Chief of *Mycologia,* now the official organ of the Mycological Society of America; Dr. Forman T. McLean, and Mr. Harold N. Moldenke. Miss Alice Aronescu, graduate student, presented a paper on "*Diplocarpon rosae*: From spore germination to haustorium formation."

Dr. B. O. Dodge was a speaker at the fall meeting of the Society for the Study of Asthma and Allied Conditions, held in New York December 9. His subject was "Common Molds." Also on the program was Dr. J. Gardner Hopkins, of Columbia University. Discussion followed both addresses.

Mr. Knowles A. Ryerson has been appointed Chief of the Bureau of Plant Industry of the U. S. Dept. of Agriculture, in succession to Dr. W. A. Taylor, retired. Mr. Frederick D. Richey becomes Associate Chief and Dr. Karl F. Kellerman, formerly Associate Chief, becomes head of a new Division of Plant Disease Eradication and Control in the Bureau of Entomology. This division will have transferred to it all activities directed towards the control and eradication of the "phony peach" disease, blister rust, barberry, citrus canker, and Dutch elm-disease.

Dr. Marshall A. Howe, Assistant Director, was elected President of The New York Academy of Sciences at the 116th annual meeting of the Academy, held at the Biltmore the evening of December 18. Dr. E. D. Merrill, Director-in-Chief, was elected a Councilor.

In the November issue of this JOURNAL (p. 247), in the list of enrolled students in the gardening courses, Mr. Thomas W. Little was erroneously referred to as connected with the "Charles Montgomery Estate." It should have been the Robert H. Montgomery Estate at Cos Cob, Connecticut.

In addition to the members of the Ninth National Shade Tree Conference held at the Garden, September 7–9, 1933, the following visiting botanists have enrolled in the library during the autumn: Dr. Ivan M. Johnston, Jamaica Plain, Mass.; Dr. Glen Gardner Hahn, New Haven, Conn.; Dr. E. H. Eames, Bridgeport, Conn.; Prof. L. H. Bailey, Ithaca, N. Y.; Mr. Edwin B. Bartram, Bushkill, Pa.; Mr. R. Kent Beattie and Mr. Curtis May, Washington, D. C.; Dr. Carlos A. Marelli, La Plata, Argentina; Dr. Albert S. Müller, Viçosa, Brazil; Mr. Harvey M. Bassler, Iquitos, Peru; M. Armand Renier, Brussels, Belgium; Dr. H. J. Lam, Leiden, Holland; and Dr. Yonosuke Okada, Sendai, Japan.

"Still pursuing his theory that blight-resistant native American chestnut trees may be developed through the encouragement of sprouts that have appeared since the blight swept most of the trees away, Dr. John Stuart Thomson, of 361 Bergen Avenue, Jersey City, N. J., again calls for voluntary coöperation in an attempt to restore this tree to its former glory. Dr. Thomson is convinced that progressive immunity can be built up for the chestnut tree and has conducted many experiments in support of his conviction. What he wishes is to hear promptly from individuals who find nut-bearing sprouts or new trees bearing burs."—[*Nature Magazine* 20: 94. 1933.]

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Gardens, including a beautiful rose garden, a rock garden of rock-loving plants, and fern and herbaceous gardens.

Greenhouses, containing thousands of interesting plants from America and foreign countries.

Flower shows throughout the year—in the spring, summer, and autumn displays of narcissi, daffodils, tulips, lilacs, irises, peonies, roses, lilies, water-lilies, gladioli, dahlias, and chrysanthemums; in the winter displays of greenhouse-blooming plants.

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JOURNAL
OF
THE NEW YORK BOTANICAL GARDEN

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1859-1934
MARSHALL A. HOWE

DO CYCADS BRANCH?
JOHN K. SMALL

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CAROL H. WOODWARD

CONTROLLING THE HOLLYHOCK RUST
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NOTES, NEWS, AND COMMENT

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Arthur J. Corbett	*Superintendent of Buildings and Grounds*

his wife, Elizabeth Gertrude, deeded a part of this land, with the old "Britton Cottage," to the Staten Island Institute of Arts and Sciences, in the hope that the old house would "long be preserved as an illustration of early colonial construction."

According to the available photographs, Nathaniel Lord Britton was a very boyish-looking youth, when, in 1879, at the age of twenty years and a little less than five months, the trustees of Columbia College conferred upon him the degree of Engineer of Mines. There was in those years no formal instruction in botany in Columbia College or its School of Mines. However, Dr. John Strong Newberry, the Professor of Geology and Mineralogy, was an "all-round naturalist of the old school," who had published a few papers on living plants and many on fossil ones. He had encouraged young Britton's botanical interests, which had been fostered by early association with Mr. John J. Crooke, on Staten Island. Crooke was a graduate of Yale, primarily a chemist and physicist, who made large collections of shells, birds, minerals, and plants. On Mr. Crooke's death in 1911, Doctor Britton wrote that he had been favored with his "intimate acquaintance since boyhood and his [Britton's] direction to lines of scientific inquiry was induced by this companionship and suggestion."[1] It is said that even as a child the young Nathaniel, when taken on drives, knew the names of roadside trees and other plants in a way that seemed very mysterious to his parents. In those early years on Staten Island, association with the slightly older Arthur Hollick, his classmate in the School of Mines, was also a factor in shaping the development of the future botanist. In company with Hollick, he joined the Torrey Botanical Club in October, 1877. Hollick and Britton's "The Flora of Richmond County, New York" was published in 1879, the year of their graduation. Britton's first appearance in botanical literature had been somewhat earlier—in the *Bulletin of the Torrey Botanical Club* for October, 1877, under the title "Staten Island Plants." After miscellaneous notes on the local occurrence of various species, he observes that on dropping open-flowered plants of *Opuntia vulgaris* (?) the radiately extended anthers are by the shock (or by a slight tap, even when not dropped) drawn in against the stigmas, afterwards, when left quiet, resuming their extended positions. This simple observation on the prickly pear was a forerunner of the sumptuous four-volume Britton and Rose monograph of "The Cactaceae" of the world! However, the implications are physiologic rather than taxonomic. His second, third, and fifth contributions, all published in the *Bulletin* while still an undergraduate in the School of Mines, have physiologic or phaenologic rather than systematic bearings. The second is entitled "When the Leaves Fall." It includes a table of 65 species of trees, shrubs, and vines, with notes as to the condition of the leaves on five dates in October and November, 1877. He observes that "the female in dioecious plants appears to hold its foliage longer than the male * * * —very strongly marked in *Ailanthus glandulosus, Acer saccharinum* and *A. rubrum,* and *Salix alba* and *S. discolor,* but not in *Populus.*" A companion piece, a few months later, is "When the Leaves Appear." Another brief paper, just before his graduation, bears the title "Notes on the Relative Age and Dimensions of a Number of Different Trees."

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[1] Journal of The New York Botanical Garden **12**: 161. 1911.

On his graduation from the School of Mines, in 1879, he became Assistant in Geology under Professor Newberry and for the five following years he was also Botanist and Assistant Geologist of the Geological Survey of New Jersey. In 1881 he published "A Preliminary Catalogue of the Flora of New Jersey" and this apparently served as his thesis for the degree of Doctor of Philosophy, which was conferred upon him in that year by Columbia College. A revised and enlarged edition of this Catalogue appeared in 1890.

On August 27, 1885, Doctor Britton married Elizabeth Gertrude Knight, daughter of James and Sophie Anne (Compton) Knight, who was not only a constant helper in all his subsequent undertakings, but also achieved individual fame as a bryologist and plant conservationist.[2] Her recent illness and death appeared to be a shock from which he never recovered. The last time that he left his rooms alive was on February 27 to lay his life companion to rest in the old Moravian Cemetery on Staten Island. Just four months later, to a day, others performed for him the same sad service.

The years following Doctor Britton's marriage were, like essentially all of his years, characterized by ceaseless mental activity. In addition to teaching, he found time for numerous obser-

[2] Journal of The New York Botanical Garden **35**: 97–104. 1934.

vations on the higher plants, most of which were published in the *Bulletin of the Torrey Botanical Club,* of which he was editor from 1888 to 1898. In 1886 his title in Columbia College was changed to Instructor in Geology and Botany and in 1891 to Adjunct Professor of Botany. During all of this time he was laying the foundations in fact, if not with full intent, for the Britton and Brown, "Illustrated Flora of the Northern United States and Canada," which came out in three volumes, 1896–98. Illustrated floras had appeared in Europe, but this was the first sustained attempt in the United States to describe its plants with a text illustration of the characteristic features of each species. The work was a popular success and now, thirty-six years after the publication of the third volume, when it is of necessity somewhat outmoded, the work still remains a good seller. It has played a great part in popularizing the study of plants in the United States and Canada, as has also its non-pictorial one-volume successor, Britton's "Manual of the Flora of the Northern States and Canada."

Doctor Britton himself is authority for the statement that the beginnings of the history of The New York Botanical Garden may be traced to a remark made to him by Mrs. Britton in the summer of 1888, when they were on a visit to the Royal Botanic Gardens at Kew, England. Mrs. Britton, impressed by the beauty and scientific interest of the plant exhibits at Kew and by the importance of the Royal Gardens' numerous contributions to the literature of the plant sciences, said, in effect: "Why couldn't we have something of this kind in New York?" At a meeting of the Torrey Botanical Club held on October 24, 1888, Mrs. Britton gave a description of the Royal Gardens at Kew. At the next meeting of the Club, a committee was appointed, consisting of E. E. Sterns, Arthur Hollick, Thomas Hogg, H. H. Rusby, T. F. Allen, N. L. Britton, J. S. Newberry, and Addison Brown, to consider the idea of establishing a botanical garden in the City of New York. At a meeting of the Club on January 8, 1889, an appeal for such a garden, prepared by the committee, was adopted and ordered printed. The consent of the Department of Public Parks was secured for the establishment of the proposed garden if sufficient means for its maintenance could be obtained. An Act of the Legislature of the State of New York, drawn by Judge Charles P. Daly and Judge Addison Brown, became a law when signed by Governor Hill on April 28, 1891. This established a corporation known as "The New York Botanical Garden"

> "for the purpose of establishing and maintaining a botanical garden and museum and arboretum therein, for the collection and culture of plants, flowers, shrubs, and trees, the advancement of botanical science and knowledge, and the prosecution of original researches therein and in kindred subjects, for affording instruction in the same, for the prosecution and exhibition of ornamental and decorative horticulture and gardening, and for the entertainment, recreation, and instruction of the people."

The list of incorporators included forty-eight names of New Yorkers of distinction. Besides the botanists Addison Brown and Nathaniel L. Britton, there were such well-known names as Seth Low, Charles A. Dana, Henry C. Potter, Cornelius Vanderbilt, Morris K. Jesup, J. Pierpont Morgan, Andrew Carnegie, D. O. Mills, William C. Schermerhorn, John S. Kennedy, David Lydig, Samuel Sloan, and William E. Dodge. The Act of Incorporation authorized and directed the Park Commissioners to set aside for the proposed Garden not exceeding 250 acres in Bronx Park or some other public park north of the Harlem River, if, within seven years, the corporation should secure by subscription not less than $250,000 "for successfully establishing and prosecuting the objects aforesaid." The first subscription, of $25,000, was made by Judge Addison Brown, and was followed by a subscription of an equal amount by Columbia College.[3] By June 18, 1895, the required $250,000 had been raised by subscription, the Commissioners of Public Parks were asked to set aside 250 acres of land in Bronx Park, and the Board of Estimate was requested to appropriate $500,000 for the erection of suitable buildings, as had been made mandatory by the act of the state legislature. A Board of Managers had already been elected, with Cornelius Vanderbilt, President; Andrew Carnegie, Vice-president; J. Pierpont Morgan, Treasurer; and N. L. Britton, Secretary. Seth Low, President of Columbia University, accepted the chairmanship of the Scientific Directors.

[3] Columbia, aside from her broad interests in education and research, had a sentimental interest in botanic gardens from the fact that the twenty acres occupied by the Elgin Botanic Garden of Dr. David Hosack—the present site of the Rockefeller Center—was donated to Columbia College by the State of New York in 1814 and has long constituted one of the chief sources of revenue of Columbia College and the subsequent Columbia University.

A little later an agreement was entered into with Columbia College whereby the herbarium and botanical library of the College were to be deposited at the Garden and the facilities of the Garden were to be placed at the disposal of teachers and advanced students of botany in the College. On June 17, 1896, Doctor Britton was elected Director-in-Chief. He immediately resigned his Columbia professorship and was made Professor Emeritus at the early age of thirty-seven years. The site of the new Garden, consisting of 250 acres in the northern part of Bronx Park, was approved by the Park Commissioners in July, 1895, and more than 140 acres were added to this in 1915, making the total area of the Garden nearly 400 acres. By agreement with the City certain restrictions were imposed upon making changes in the "Hemlock Grove" bordering the Bronx River. The development and planting of the remaining area occupied the attention of Director Britton and his assistants for the next thirty-three years. The training in engineering received by him while a student in the School of Mines was often put to practical use in laying out the grounds. But the physical plant of The New York Botanical Garden was never more than a means to an end with Director Britton. His first thought was always for scientific research and the publication of its results. In the autumn of 1900 he spent seven weeks abroad, attending the International Congress of Botanists held in conjunction with the Paris Exposition, and visiting some of the larger botanical gardens and herbaria of France, Switzerland, Germany, and England, arranging exchanges of herbarium specimens, books, seeds, and living plants and studying methods of culture and display of plants. One of the general conclusions drawn from this European visit was the following:

> "As to the general features of the foreign institutions as compared with our own, I would report that the botanical gardens and museums of Berlin, London, and Paris are naturally far in advance of us at present, in the number of species in cultivation and in the size of their herbaria, libraries, and museum collections, and in the development of the grounds. But as regards site, soil, natural topography and buildings, none of them compare with Bronx Park at all favorably."

Botanical exploration of the West Indian region, which was to become such an important feature of the Garden's activities during its first third of a century, was begun by an expedition to Porto Rico by Mr. and Mrs. A. A. Heller in 1898, financed by Cornelius Vanderbilt. Dr. Britton's first personal participation in this West Indian exploration was in 1901, when, in company with Dr. John F. Cowell, Director of the Buffalo Botanic Garden, he spent a few weeks on St. Kitt's (St. Christopher's) of the Leeward Islands group. A paragraph in his report foreshadows the general policy of the Garden in its field work during many succeeding years:

> "The personal reconnaissance of the West Indian flora, taken together with other considerations, has convinced me that our exploration work for a series of years had best be mainly done in the West Indies and Central America. It is certain that this course would bring to light a very large number of species new to science, and the specimens illustrating them, as well as other species of rarity, would greatly enrich our collections in all departments. It would render more complete our work on the systematic botany of North America, and would tend to make the plants of tropical America more accurately known, and thus have an important bearing upon the increasing commercial relations of the United States with the countries to the south of our present domain. I hope to present, in the near future, a plan for this proposed system of exploration."

Dr. Britton himself participated personally in no less than thirty botanical visits to the West Indies, mostly at his own expense.

In 1901, a plan for the publication of the "North American Flora" was adopted and its preparation referred to Professors L. M. Underwood and N. L. Britton. The work was to be complete in thirty volumes (afterwards extended to thirty-four) and "North America" was to be interpreted liberally, to include Greenland to the north and the Republic of Panama and the West Indies on the south. The coöperation of prominent botanists outside of the Garden staff was assured, but the magnitude of the task and other activities of the leading contributors have operated to slow down publication to a greater degree than was anticipated by the original promoters of the ambitious enterprise. At the present time, twenty-nine years after the appearance of the first part, seventy-four parts have been published and only one volume of the proposed thirty-four is complete. It is hoped that ways may be found to bring this great undertaking to a reasonably early completion.

Dr. Britton was one of the prime movers in the framing of the so-called "Rochester" and "American" codes of botanical nomenclature, which emphasized the priority principle in the selection of the valid Latin names for genera and species of plants. The adoption of these principles by Britton in the "Illustrated Flora," the "Manual," etc.; by Small in his "Flora of the Southeastern United States"; by Rydberg in his "Flora of the Rocky Mountains"; and by various other contributors to the literature of systematic botany, led to a wide use of names that, in many cases, were different from those that had been made familiar by the earlier American manuals. Attempts to have the "American Code" adopted in its essential entirety by all of the botanical world have failed, yet many of its distinctive features are recognizable in the latest revision of the "International Rules of Botanical Nomenclature." Much of the diversity in nomenclature that still persists is due to differing ideas as to generic and specific limits. Genera and species being essentially subjective concepts rather than objective realities, their material content does not seem to be subject to successful legislation by botanical congresses.

In his limitation of species, Doctor Britton was, on the whole, rather "conservative," but in defining genera his tendency to "split" rather than to "lump" is perhaps especially notable in the handsome Britton and Rose four-volume work on "The Cactaceae" published by the Carnegie Institution of Washington in 1919–23. Britton and Rose recognize 124 genera and about 1,237 species. A third of a century earlier, Dr. K. Schumann, in his treatment of the Cactaceae in Engler and Prantl, "Die natürlichen Pflanzenfamilien" recognized 20 genera and about 775 species. While the increase of genera from 20 to 124 was largely of the "splitting" or "segregating" type, in conformity with the general trend of biological practice, it is an indisputable fact that Britton and Rose had at their disposal vastly more material than was available to any of their predecessors, and the increase in the number of recognized species from 775 to 1,237 represented a notable advance in actual knowledge of the living forms exhibited by the Cactus Family. This elaborate monograph doubtless represents the climax of Doctor Britton's contributions to scientific literature. It has established a new datum line from which future investigations of the Cactaceae must proceed. In a letter received at The New

York Botanical Garden since the death of Doctor Britton, a well-known Japanese botanical author has written:

> "It is my ardent intention to translate this masterpiece into Japanese and to publish it in the near future for the many botanists, gardeners, Britton devotees, and others to be found among my fellow-countrymen, who would consider the work a boon."

Especially noteworthy among Doctor Britton's later publications are the "Flora of Bermuda" (1918), "The Bahama Flora" (1920, with C. F. Millspaugh), and the "Botany of Porto Rico and the Virgin Islands (Spermatophyta)" (two volumes, 1923–1930, with Percy Wilson), all representing great advances over any previous works in the same field.

Doctor Britton was always recognized as the moving spirit in organizing the "Scientific Survey of Porto Rico and the Virgin Islands" under the direction of a committee of the New York Academy of Sciences, with the coöperation of The American Museum of Natural History, The New York Botanical Garden, and some of the scientific departments of Columbia University and other institutions. The Government of Porto Rico has assisted the enterprise by substantial appropriations of money and the two agricultural experiment stations, one at Mayagüez and the other at Rio Piedras, have coöperated. Up to the present date, five of the projected eighteen volumes of the reports of this Scientific Survey, together with eighteen parts of other volumes, have been published. While the members of this Survey committee will feel that they have sustained an almost crushing loss in the passing of their constructive leader, it seems probable that the momentum already given to the project by him will suffice to carry it through to essential completion. Nothing comparable has ever been published for any other West Indian islands. Doctor and Mrs. Britton had spent many winters in Porto Rico, and they were held in high esteem there. Several messages of sympathy were sent from the island to Director Merrill, when the news of Doctor Britton's death was received. Besides radiograms from Acting Governor Horton and others, J. A. B. Nolla, Acting Commissioner of Agriculture and Commerce, radioed:

> "News of death of beloved Dr. Britton a shock to his host of Porto Rican friends. Please convey to his associates and relatives condolences Department of Agriculture Porto Rico and my own."

The Committee on Mineral Resources sent the following:

> "Porto Rico loses a great friend in the death of Doctor Britton, President. Please convey heartfelt regret to his family and the staff of the Garden."

According to a list compiled by Mr. Percy Wilson, five genera of plants and one of animals have been named in honor of Doctor Britton and one of mosses in honor of Mrs. Britton. These are:

BRITTONAMRA Kuntze, of the Pea Family, with 1 species, a native of tropical America.

BRITTONASTRUM Briquet, of the Mint Family, with 15 species, natives of Mexico and the western United States.

BRITTONELLA Rusby, of the Malpighia Family, 1 species, native of Bolivia.

BRITTONELLA Fisher, a genus of beetles, 1 species, native of Porto Rico.

In naming this genus, Dr. Fisher remarked:

> "I take great pleasure in dedicating this genus to Dr. N. L. Britton, director for more than three decades of The New York Botanical Garden, chairman of the Porto Rico Committee of the New York Academy of Sciences, to whose able and indefatigable services is due in large part the success of the Natural History Survey of Porto Rico."

BRITTONROSEA Spegazzini, of the Cactus Family, 21 species, natives of South America.

BRYOBRITTONIA, of the mosses, 1 species, native of Yukon Territory.

NEOBRITTONIA Hochreutiner, of the Mallow Family, 1 species, native of Mexico.

Sixty-nine species and varieties of plants, living and fossil, and three of animals have been dedicated to Doctor Britton, while fifteen species of plants and one of animals have likewise been named for Mrs. Britton. In addition, two species of plants, a palm (*Copernicia Brittonorum* León) and a beard-tongue (*Penstemon Brittonorum* Pennell) appear to have been named for the two conjointly.

Brittonia, a periodical, issued at irregular intervals and devoted chiefly to papers on systematic botany, was established by The New

York Botanical Garden, at the suggestion of Doctor Britton's successor, Dr. E. D. Merrill, in 1930, the first number appearing in 1931.

Doctor Britton was honored with the presidency of the Botanical Society of America for the year 1897–98, and again, of the larger more democratic Society, for 1921, and he and Mrs. Britton were patrons of this Society. As he advanced in years, he developed a reluctance to traveling (unless on board a steamer headed southward) and also to making public addresses. When the time came for him to deliver an address as retiring President of the Botanical Society of American at Toronto in December, 1921, he sent a substitute, bearing his check for $1,000 drawn to the order of the Society, in lieu of a formal address!

With his friend Doctor Arthur Hollick, Doctor Britton was active in organizing and developing the Natural Science Association of Staten Island (now the Staten Island Institute of Arts and Sciences) and was its President, 1888–91. He was also actively interested in the Torrey Botanical Club and the New York Academy of Sciences, of which he was President for two years (1906 and 1907). In 1913, he was honored with the presidency of the New York State Forestry Association. Doctor Britton received the honorary degree of Doctor of Science from Columbia University in 1904 and the degree of Doctor of Laws from the University of Pittsburgh in 1924. He was a member of the National Academy of Sciences, the American Philosophical Society, the American Academy of Arts and Sciences, a foreign member of the Linnean Society of London, the Czechoslovakian Botanical Society, the National Medical Institute of Mexico, Honorary President of the International Desert Conservation League, the Cactus and Succulent Society of America, etc.

Doctor Britton was of slight and apparently frail physique. Many of his friends marveled that he could hold out and keep active until several months after the seventy-fifth anniversary of his birth. He retired from the directorship of the Botanical Garden on August 1, 1929, when in his seventy-first year. Many men would have been content then to rest upon their achievements, especially if their achievements had been as notable as his, but an indomitable urge and ingrained habit kept him busy with his studies of the Cyperaceae and of the flora of his beloved Porto Rico until within a few months of the end. Doctor Britton was a man of simple habits of life and of modest demeanor. He was of a usually placid and cheerful temperament, which was notably manifest during the long weeks of suffering that preceded his death. He left a sister and a brother, Harriet Louise Britton and Richard H. Britton, both of Great Kills, Staten Island. Doctor and Mrs. Britton had no children. In a way that was very real to them, The New York Botanical Garden was their child.

During his directorship of thirty-three years—a short space of time as the world goes—Doctor Britton had seen The New York Botanical Garden develop from little more than an idea to a well-developed tract of nearly 400 acres, with handsome buildings, an herbarium of more than 1,700,000 specimens, and a library of 43,500 bound volumes. As many have remarked, The New York Botanical Garden is a living monument to Nathaniel Lord Britton. It is a noble monument—a monument worthy of the man!

Marshall A. Howe.

DO CYCADS BRANCH?

In many text-books of botany and in floras one may find statements like, "Tropical plants, with an unbranched cylindrical trunk, increasing like palms by a single terminal bud; ——." Such phrases occur in descriptions of cycads. It is true that cycads, at least those with aerial erect stems, as we usually see them in cultivation, are simple-stemmed. Those with underground stems in cultivation we cannot vouch for one way or another.

Florida can boast of four species of the cycad *Zamia,* the commercial name for which is Florida-arrowroot. The popular names are coontie, conti, comptie, comfort-root, and wild sago.

Two paragraphs of information, the first from Commodore Ralph Munroe of Miami and the other from the late Mrs. Mary A. Noble of Inverness, are inserted here.

"As to cultivation of Coontie, think I am safe in stating that it never has been successfully done. It was about the first southern Florida production that I attempted to commercialize, but from all sources available at that time—1882—up to the present, have never

DR. STOUT DOES HONOR TO THE DAYLILIES

Daylilies from the botanical, historical, and horticultural points of view are treated in thorough manner in an attractively illustrated book[1] which has recently come from the pen of Dr. A. B. Stout.

Using the large collection he has made of the genus *Hemerocallis* at The New York Botanical Garden as a background for his study, he has supplemented his observations with information from important growers in other parts of the world, and has combined all this knowledge in a volume of distinct horticultural value.

The new varieties of daylilies which may now be obtained—far different from the old-fashioned lemon and fulvous daylilies—open up splendid new possibilities for landscaped effects in the garden. For these new varieties, some fifteen of which are Dr. Stout's own creations, are larger, more floriferous, and, with their occasionally twisted petals and often sprightly tones of red, more decorative in form and color. In height, too, great diversity is offered, as shown in one striking picture in which photographs of six kinds are reproduced to the same scale, showing flower stalks varying from six inches to six feet.

In his hybridizations, which are noteworthy, Dr. Stout has sometimes used wild species heretofore unknown, which were especially imported from China and Japan for his use. These are now to be seen growing in the specimen planting of daylilies on the west side of the grounds of The New York Botanical Garden.

Dr. Stout's book, which describes every known variety and gives complete cultural directions for this brilliant, easy-to-grow flower, gives gardeners their first complete picture of the genus *Hemerocallis* and how it can be used to create new beauty spots in the garden.

Carol H. Woodward.

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[1] Stout, A. B. Daylilies: The wild species and garden clones, both old and new, of the genus Hemerocallis. Pp. i–x + 1–119. Pl. 1–36. The Macmillan Co., New York. 1934. $3.00.

CONTROLLING THE HOLLYHOCK RUST[1]

Now that the hollyhock season is over it is time to begin operations designed to control the rust disease that is so often prevalent in our flower gardens. This parasite is one of the simplest of the rust fungi. It is now known that the brown spores found in the rusty spots on the leaves and stems germinate just as soon as they are mature if provided with moisture. During germination the spots turn color from brown to ash gray. As many thousands of sporidia, each capable of initiating a new infection, are developed on the spots, one understands how it is that the leaves become so heavily infected and how difficult it is to prevent the spread of the infection once the rust has become established.

Since the rust appears early in the spring with the first leaves, one might suspect that the parasite overwinters in the roots or crown. A noted Scandinavian pathologist always claimed that the hollyhock rust is perennial in its host, appearing with the new growth in the spring. This claim has been thoroughly disproved, however. Every spot on a leaf is the result of a new and separate infection. Very late in the season the new crown leaves may become infected. This new infection may carry the fungus through the winter, as the plants are dormant.

The brown spores may also remain viable all winter and so infect the first spring leaves anew. In either case it shows how important it is to destroy all of the old infected plants, stems as well as leaves, after the blooming period. Otherwise, the infected parts bearing spores collect on the ground over the crowns and thus they either bring infection to the tips of the late fall crown leaves, so that the fungus goes into a dormant condition along with these leaf primordia, or the spores, living over winter, cause the early leaves to become infected.

It is often stated with some confidence by authors that the hollyhock rust can be controlled by dusting the plants with a fine grade of sulphur. Any one who has tried this after the infected plants have reached some height knows that such measures are not always successful. It requires only about twenty-four hours for the spores to germinate and penetrate the host tissues, and some six to ten days for new pustules to mature. New leaves are con-

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[1] *Puccinia malvacearum.*

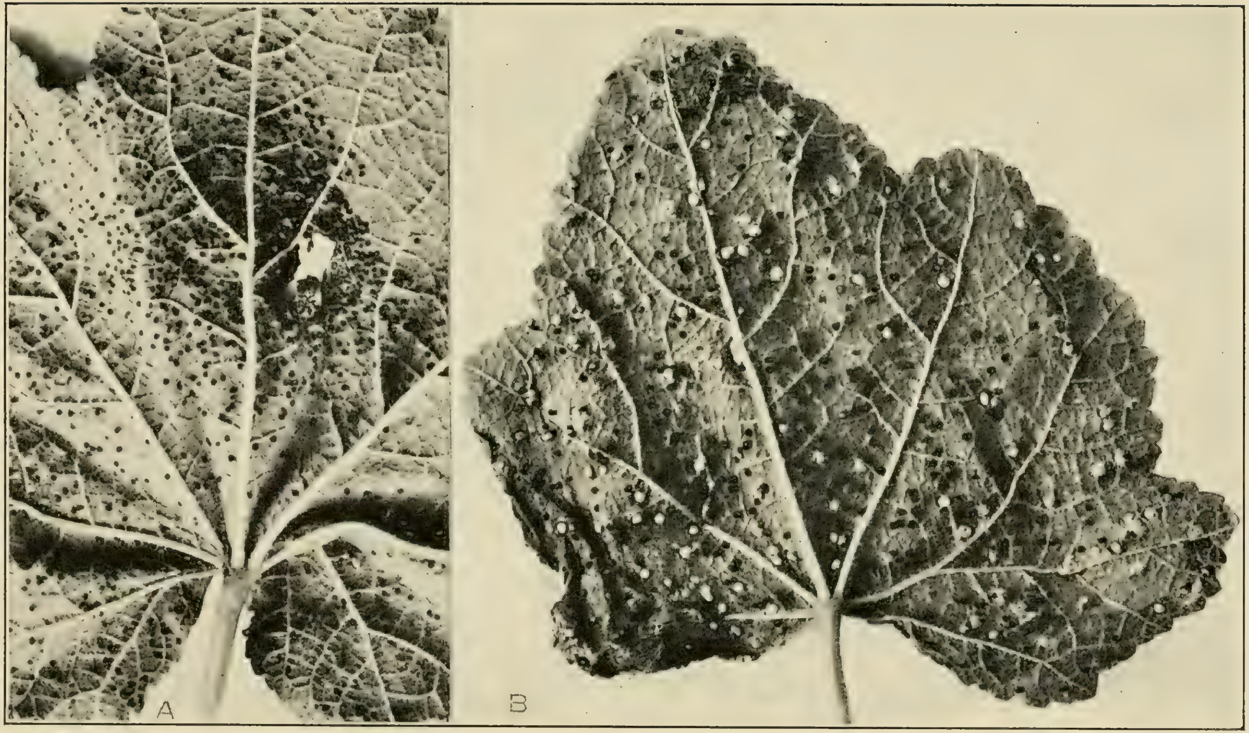

FIGURE 1. A. Hollyhock leaf so heavily infected on one area at the center that the leaf tissues were killed and pieces of the leaf were falling out. The leaf was taken during a period of very dry weather; the spores had not germinated. B. The dark spots represent rust pustules whose spores had not germinated. The white spots indicate that the spores in these pustules had germinated.

tinually unfolding and new rust pustules are continually breaking forth, so that unless one were to dust his plants every day, new infections are found to develop if there is sufficient moisture to induce the spores to germinate.

Some years ago the writer's attention was directed to a case of heavy infection of seedling hollyhocks that had been grown in flats in a cold-frame. The seedlings were about five or six inches high and heavily rusted. They were taken from the cold-frames and thoroughly dusted with Pomo-green, and, after they had been planted in the borders, the dust was applied two or three times a week until the plants had reached some size, with very satisfactory results. Just how the seedlings originally became infected is not clear. Probably rust pustules were carried over on fragments of the fruit scales or on pieces of leaves, and the infection spread to the young leaves in the moist cold-frames. The plants in our perennial borders were kept free from the rust for the two succeeding years with very little attention given them beyond a few applications of dust in the spring and the careful destruction of old plant parts. Last year, however, perhaps owing to the introduction of several new varieties, the rust appeared in epidemic form in plants about two feet high. In spite of repeated applications of sulphur dust, the rust persisted until the end of the season. A thorough clean-up of the old infected plants and a careful dusting this spring as the leaves appeared served to give us rust-free plants. There were only two plants out of a large number that showed any rust. These evidently had escaped notice until they were about a foot high, when it was found that practically every leaf was spotted with the rust. Infected leaves were removed and the plants were thoroughly dusted about twice a week. This did not prevent the rust from developing considerably on new leaves as they unfolded. It is clear from this that successful control measures must involve the prevention of the earliest infections. The removal of infected leaves is not sufficient, as rust pustules often develop on stems and a single pustule alone serves as a great source of trouble.

To control hollyhock rust: A. Destroy all plant parts after blossom time so that no infected material can come in contact with the new leaves developed in late summer and fall. B. Dust the young leaves the following spring with a good grade of dusting sulphur as soon as they appear, in March or April. Repeat once a week until blossom time. The sulphur dust will also help to control the red spider mite.

B. O. Dodge.

DISTRIBUTION OF SEEDLING DAYLILIES

Early in July a notice was sent to all members of The New York Botanical Garden that seedling daylilies to the number of 1200 would be distributed and that as long as this supply lasted ten plants would be given to any member who called or sent for them. The response was such that 1400 plants were distributed.

These seedlings were grown in connection with the work of experimental breeding and were being discarded to make room for new seedlings. They are of value chiefly for use in naturalistic plantings at this time when plants of most of the named varieties of daylilies can not be supplied in quantity by nurserymen. Many of these seedlings surpass certain of the varieties that have been named for culture as garden plants; but they are not considered as good as the selection seedlings and it is not expected that any of them will be named and propagated for special culture in gardens.

Several hundred of the best seedlings in the cultures of daylilies have been selected for critical study and comparison, and for use in further breeding. The New York Botanical Garden is not able to propagate these choice seedlings either for sale or general distribution and this is being done by nurserymen. Already thirteen selection seedlings have been named as clonal varieties and described and illustrated in *Addisonia,* in the Journal of The New York Botanical Garden, or in other publications available to gardeners. Several are being offered to the trade in the catalogs of nurserymen. There are also many seedlings of special charm and merit and there are various distinctly new types, especially in dwarf plants and in plants with numerous small flowers, with bicolored flowers, and with a wide array of attractive red colors. Nearly all of these seedlings are complex hybrids that do not breed true from seeds. The individual seedlings of special merit must be multiplied by repeated division. This is being done by nurserymen as rapidly as possible.

A. B. Stout.

NEW BOOKS FOR AMATEUR GARDENERS AND NATURALISTS

Among the books which have recently been acquired by The New York Botanical Garden and placed on the library shelves for the reference of the public are the following new volumes, all published within the last few months:

A Picture Book for Gardeners[1]

A new type of gardening book has just been prepared by G. A. Stevens, who has apparently designed it to serve as a picture guide for that vast crop of amateurs that springs up every year.

It is like a glorified catalogue of flowers, in which one looks vainly for the dealer's name. The colors at times are garish, though no more so than one is accustomed to seeing in most of the seed catalogues.

Subjects are arranged alphabetically, from Abelia through Zinnia, with a preponderance of roses, lilies, and tulips. The index, a thorough one, is an aid to the perplexed reader who finds some flowers listed by their common, and some by their scientific name. Both names, however, are usually mentioned in the text, which in most cases gives brief cultural directions for the plants.

The illustrations are made and produced by the J. Horace McFarland Company.

All about Terraria[2]

The first volume to appear since glass gardens assumed a place of decorative importance in the home has been prepared by Mildred Norton Andrews. First telling what glass gardens are, she proceeds to explain the principles underlying their construction, tells how to make them, how to plant and care for them, and how to use them in an indoor decorative scheme. The book is well illustrated, and in the appendix is offered a judging scale for gardens in glass or for specimens in glass containers at flower shows.

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[1] Stevens, G. A. Garden flowers in color. 320 pages, more than 450 illustrations in color. The Macmillan Co. New York. 1934. $3.75.

[2] Andrews, Mildred Norton. Gardens in glass. Pp. 120, illust. A. T. DeLaMare Co. New York. 1934. $1.50.

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During this time every effort is made to build up good flowering-sized bulbs for the following season and with this end in view feeding at frequent intervals with dilute fertilizers is necessary. The completion of the growing season is indicated by the maturing of the foliage. When this stage is reached feeding should cease and the moisture supply be gradually reduced, until the leaves have died down completely. Then water is withheld altogether and the soil in which the bulbs have grown is kept quite dry until the season for repotting arrives again. It is important that this drying-off process be done very gradually, as a sudden cessation of watering will seriously interfere with the quality of flowers produced the following season.

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The cultivation of South African annuals will be treated in a forthcoming number of the Journal.

T. H. Everett.

THE LEMON DAYLILY (*HEMEROCALLIS FLAVA* L.): ITS ORIGIN AND STATUS

When, where, and how the familiar Lemon Daylily (*Hemerocallis flava*) came into culture are matters of horticultural interest. What its nearest wild relatives are and where they now grow are especially matters of botanical interest. It is the purpose of this article to summarize and to evaluate the evidence on these questions, with special reference to the origin and development of this plant.

The Lemon Daylily is one of the oldest of plants cultivated in flower gardens, for it was already in cultivation in Europe when the first books were written about such plants. It was fairly well described in a volume (Pena and Lobel, Stirpium Adversaria Nova, 1570) under the name *Asphodelus luteus liliflorus*. It is stated that it was then familiar as a cultivated plant in gardens in France and Holland but not in Italy, that it was listed by the "Pharmacopoei Veneti," and that its medicinal product had been seen in shops, especially in Antwerp.

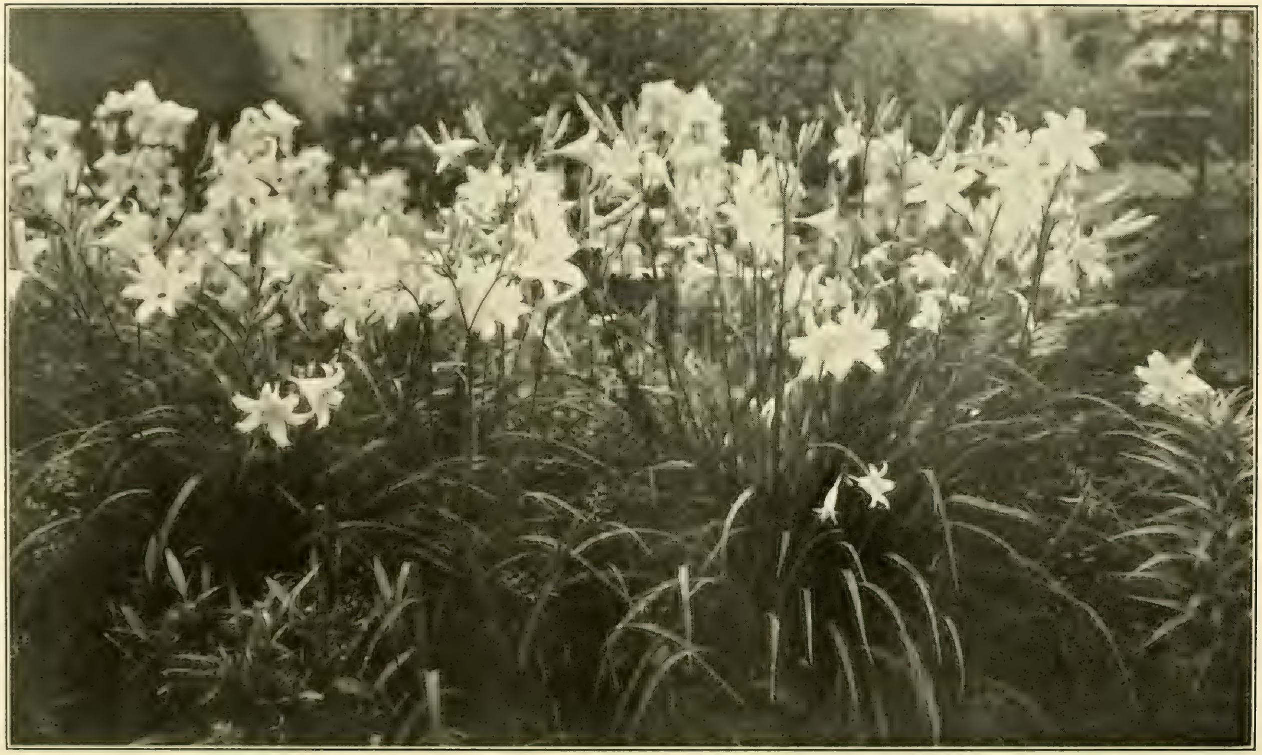

FIGURE 1. Well-grown garden plants of the Lemon Daylily. Evidently these are of the same clone which was first described in 1570 and which was later designated by Linnaeus (1762) as *Hemerocallis flava.*

Six years later (in Historia, by Lobel, 1576), there was printed an excellent woodcut of this daylily showing an entire plant (see FIGURE 3). This is the first illustration known for any plant of the genus *Hemerocallis* as now recognized. It is certain that this plant was then being propagated vegetatively by division as a garden clone and that it has continued to be thus propagated until the present time. Hence, the plants of this particular type now growing in our gardens are merely pieces of the same individual illustrated more than three and one half centuries ago.

Some of the earlier writers recorded certain ideas regarding the natural home of this plant. Clusius in 1601 (Rariorum Plantarum Historia) states that he had found it growing wild in Austria. Linnaeus, who first called the plant *Hemerocallis Lilio-Asphodelus flavus* (Species Plantarum, 1753), states that its habitat was Hungary and Siberia. We should note that later he decided to name this plant *Hemerocallis flava* (Species Plantarum, second edition, 1762) and that this is the botanical name which has continued in use. Miller (Gardener's Dictionary, 1768) states that this daylily grew in Hungary, Dalmatia, and Istria. Numerous references since that date cite the plant as wild in certain parts of Europe and in Siberia.

A recent letter from Professor August Ginzberger, of Vienna, Austria, states that the colony of *Hemerocallis flava* observed by Clusius in the year 1580 is still in existence. The location is near Güssing in the area called Burgenland. Professor Ginzberger has kindly offered to go to the colony and obtain living plants for shipment to The New York Botanical Garden and plans have been perfected for him to do so.

We may first consider whether *Hemerocallis flava* L. and also the *H. fulva* clone Europa exist in the wild in Europe as indigenous plants or merely as early escapes from cultivation. A recent flora (Hegi und Dunzinger, Illustrierte Flora von Mittel-Europa, vol. 2, p. 205) reports that these daylilies grow wild or naturalized outside of gardens, but chiefly in the vicinity of cloisters and old castles, over a rather wide area of middle Europe. It is stated that the *H. flava* seeds freely but that the *H. fulva* never produces seed, although it is more widely distributed as an escape. The *H. fulva* of Linnaeus (the Europa Daylily) is merely a triploid clone which happens to be completely self-incompatible and also so nearly im-

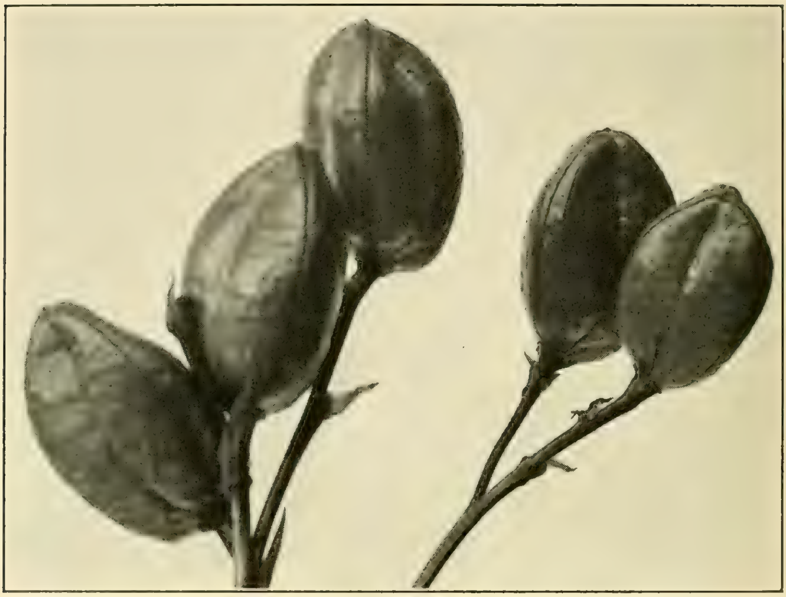

FIGURE 2. Capsules of the Lemon Daylily, nearly natural size, obtained by controlled self-pollination. The large size and elliptic shape of the capsules are characteristics that distinguish this plant from all other yellow-flowered species now known.

potent from the sterility of triploidy that it rarely sets seed to any sort of cross-pollination. Its distribution has involved only the transfer of pieces of the living plant. This clone is botanically to be included with a type widely distributed in the Orient, both as wild and as cultivated plants. Since this Europa Daylily undoubtedly came to Europe from Asia it seems reasonable to assume that the Lemon Daylily also did. The evidence seems to indicate that both the Lemon Daylily and the Europa Daylily were already somewhat naturalized in Europe, at least in Austria, as early as 1580, at which time they were more widely cultivated as garden plants.

Various publications on the floras of Siberia, China, and Japan state that *H. flava* is an indigenous species and there are also numerous specimens labeled *Hemerocallis flava* L. in herbaria of collections made in these countries. From these data one would naturally conclude that this species is widely distributed in the Orient. For many years the writer concurred in this view, but after further critical study he now questions this evidence.

The best plant material for study of the identities of daylilies is of course living plants. During the past few years various shipments of living plants and of seeds labeled *Hemerocallis flava* have come to The New York Botanical Garden from rather widely separated districts of the Orient. Also seeds or plants of unnamed yellow-flowered daylilies have been received and grown. In no case has any plant thus obtained even closely resembled the type of *H. flava* L. which is still in general culture in Europe and America. Furthermore, a careful inspection of the descriptions of *H. flava* in floras of the Orient and of the herbarium specimens from this area does not reveal any type of *Hemerocallis* that can be definitely assigned to the *H. flava* of Linnaeus.

The type or clone of Lemon Daylily (FIGURE 1) most gen-

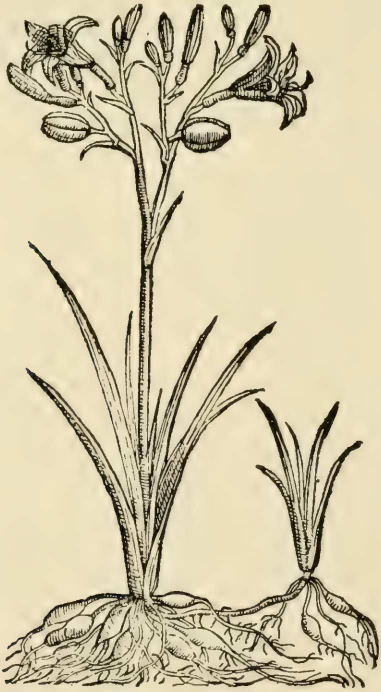

FIGURE 3. This illustration of the Lemon Daylily is from a photograph of a woodcut published in Lobel's Historia in 1576. In respect to the large size and the shape of the capsule, as well as in numerous other characters, the clone of the Lemon Daylily most commonly cultivated at the present time appears to be the same as the plant here illustrated.

erally cultivated in Europe and America is distinct and very different from all other types or species of daylilies now known. In the region about New York it flowers early in spring at the same time that *Hemerocallis Dumortierii* and *H. Middendorffii* do. Its flowers are medium-large, fairly full, clear lemon-yellow in color, agreeably odorous, widely open by day and they regularly remain open for at least 24 hours. The capsules (see FIGURE 2) are nearly triangular in cross-section, elliptic in shape, and much larger than those of any other of the older types of daylilies; and they conform to the capsules shown in the woodcut published in Lobel's Historia in 1576. The scapes are branched and about three feet tall. The stems of the crown spread rather widely underground to form rhizomes. The roots are noticeably enlarged and fleshy.

As a rule the yellow-flowered daylilies obtained from the Orient have bloomed later than the Lemon Daylily, the capsules are decidedly different in shape and size, and they all possess other obvious differences.

The type clone of the Lemon Daylily is highly self-fruitful and the plants readily produce large capsules and numerous seeds to controlled self-pollination or even to autonomous self- or close-pollinations which may be effected in the garden by large diurnal butterflies or large nocturnal moths. About forty seedlings have been grown at The New York Botanical Garden from seed of controlled self-pollinations of this plant. All these plants show the essential botanical characters of the parent, but there are decided variations in the size and the fullness of the flowers (see FIGURE 4) and in vigor and hardiness; and, although some have had larger flowers, none has surpassed the parent as a desirable garden plant. This may explain why the plant has been propagated in horticulture as a clonal variety rather than as a seed variety. It is readily and easily propagated by division, giving plants of the same individual characters, and this method has evidently been employed since this daylily was first cultivated. It is stated that the naturalized plants of *H. flava* now growing in middle Europe produce seeds, and presumably these may be a means of extending the distribution. If so, some variation in the plants may be expected. The variations which the writer has observed in the selfed progeny and in the F_1 progenies of hybridization involving the type clone of *H. flava* are, however, not sufficient to indicate that this plant is itself a hybrid.

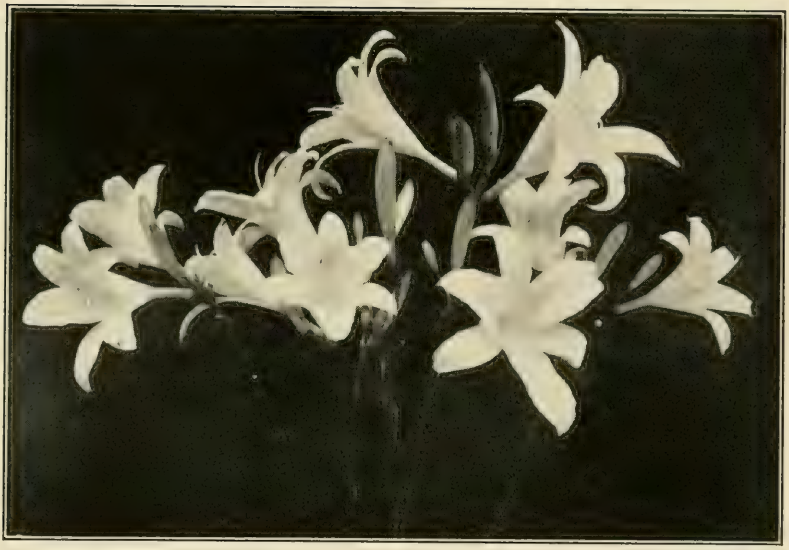

Figure 4. Flowers of four seedlings grown from selfed seed of the Lemon Daylily. There is some variation in the size and the fullness of the flowers.

There are several somewhat different clones in garden culture which resemble the Lemon Daylily and seem to be related to it. One of these, which came to The New York Botanical Garden as *Hemerocallis minor,* has smaller flowers, very erect foliage, and beaked capsules. This clone is self-incompatible but readily crosses with the Lemon Daylily. Various of the plants received as *H. flava* from botanical gardens in Europe are somewhat different from the type clone. The name "*H. flava major*" is applied both to the type and to other daylilies. Some of the garden clones called *H. flava* and *H. flava major* are certainly hybrids; others may have arisen as seedlings of the original clone of *H. flava.*

In respect to the chromosome number, the Lemon Daylily has 22 (2 x 11), which is the normal diploid number for the genus. It is not unusual or noteworthy in its chromosomal complex, as is the triploid *H. fulva* clone Europa.

Eastern or central Asia is without doubt the native home of the daylilies and the center of their natural evolution, origin, and distribution. Certain of them are of ancient cultivation in the Orient for food, for medicinal uses, and as garden flowers. The Lemon

Daylily, together with the fulvous Europa Daylily, was probably taken from the Orient to Europe at an early date, primarily for the medicinal uses noted by Pena and Lobel in 1570. But the Lemon Daylily was and still is an excellent plant for flower gardens and in this use it has continued in culture to the present date.

Cultivated plants are often very different from the wild species from which they arose. When they are not hybrids or polyploids but selections or developments from a wild species they usually possess its essential specific characters but they may differ greatly in characters such as vigor, habits of growth, and size of flowers. Such variations are often important in horticulture, especially when they may be continued by clonal propagation.

The plant named *Hemerocallis flava* by Linnaeus in 1762 had then already been cultivated in Europe for at least 192 years, and it has continued to the present time by clonal propagation. In portions of middle Europe it has become somewhat naturalized and possibly this has involved reproduction by seeds. In America it persists in abandoned garden sites but does not spread readily and become naturalized as does the *H. fulva* clone Europa. There is no indication that the plant is itself a hybrid or a polyploid mutation. At the present time there is no reliable evidence that a wild species which has the essential botanical characters of this plant exists in the Orient. Possibly such a species does exist there but has not been discovered or at least accurately described. Until adequate descriptions are available for the types of wild and cultivated daylilies in the Orient, one can scarcely make a satisfactory conclusion regarding the origin of this old familiar garden plant, the Lemon Daylily.

A. B. Stout

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are being sown alongside one another. Thus each kind can better be kept separated. The depth at which the seeds are covered is very important. It is well to keep in mind that we are *sowing* seeds, or, if you like, call it scattering seeds and not burying them. An old rule is to cover to the depth of the seed you are dealing with, and I would say very often, cover even less. The important thing is, water them well with a fine nose on the can, and shade constantly until germinated. Avoid as far as possible airy, drying conditions. All this frame sowing applies in the main to quick-germinating material that has been handled often in quantity and that is invariably offered in seed catalogues.

When we come to choicer things—to *Primula,* to *Ramondia,* to seeds of hard-wooded plants, and to new things, the better way is to sow in pots—flats if you will, but I prefer pots. A five-inch pot is the smallest I would use. Smaller ones take up less room, but they have a tendency to dry out too quickly. Ample drainage should be used, and the soil should consist of a mixture of equal parts of loamy soil, leaf-mold or peat, and grit or sharp sand. In the case of the Ericaceae, which includes *Rhododendron, Daboecia,* and that delightful plant, the trailing arbutus—if you can grow it—peat and sand should be the medium. Fill the pots to within half an inch of the top. The top layer should be put through a very fine sieve. Press the whole down and water to saturation. If the middle of this surface is slightly raised it will impede drying out at the sides of the pot. After the actual water and muddy condition have gone, the seeds should be sown thinly. The depth to cover is as important here as in the frame. Before sowing very minute seeds, it is advisable to mix them with a pinch of dry sand so that a more uniform spread will be obtained. These last should receive no covering at all. After sowing, the pots should be removed to a frame, stood close together, and covered with heavy brown paper. Over this may be added a four-inch covering of moist sphagnum moss, or anything that will assist your efforts in maintaining an evenly moist condition.

Little watering will be necessary for some time. Examine every few days, until some of them begin to germinate, when more constant daily watchfulness will be essential. As every species germinates it must be removed to where light and air can be admitted. Close proximity to the glass is important, otherwise weak growth will result. It will be found that from this point they will require more water and that must be determined according to the time of year.

There will be some, perhaps many, that have not germinated, and those will probably be the kinds that require freezing. The first transplanting of these is rather important, and as soon as they can be handled easily, or perhaps I should say as soon as the second leaf appears, it will be better to transplant, or prick them off. In the dull months this move is very important for those that have been frozen and brought into a greenhouse in early spring. It will invariably prevent damping-off.

Transplanting should be done in as high a temperature as that in which the seeds have germinated. The soil should be similar to the seeding soil, except that it need not be quite so fine, and a little lime can be added with advantage to subjects we know are lime-lovers.

In pricking off, use a fine-pointed, hardwood dibble. The beginner should be cautioned not to press the soil to the neck or stem of the tiny plant, but to the roots. These seedlings, if alpines or herbaceous perennials, should be spaced widely enough to allow them to grow sufficiently large to go into their flowering quarters when next moved. Most shrubs and trees can be left in the seed-pan until growth commences outdoors in spring. They may then be planted in nursery rows and watered thoroughly.

JAMES ESSON.

THE PENCIL-CACTUS (RHIPSALIS) IN FLORIDA AND AT THE GARDEN

On August fifth, 1923, the genus *Rhipsalis* was first collected in Florida. This also was the first time it had ever been found at a point north of the Tropic of Cancer. Two associates of the undersigned, Charles A. Mosier and John B. DeWinkeler, discovered it high up on tall live-oak trees. They managed to dislodge a large plant and sent it intact to the Garden by express. Upon arrival at the Garden the base of the plant with its roots was attached to the bark of a section of a freshly cut oak tree (though not a live-oak) in order to make the plant feel at home. The exhibit was placed in the cactus house in Conservatory Range 2, and allowed to grow.

THE FIVE-YEAR PROJECT OF THE GARDEN CLUB OF AMERICA

An impressive evidence of the extent of popular interest in gardening is the announcement of Five-Year Study Projects proposed by the Horticultural Committee of the Garden Club of America. A detailed program has been published, using the genus Hemerocallis as a type, for a complete study of any single group of perennials, particularly in reference to practical cultivation, with the purpose of assembling data from all parts of the country and ascertaining the horticultural requirements and regional adaptability of varieties.

The selection of the daylily is perhaps indicative of the special activity and attention which has centered upon this particular genus in recent years, an activity in which Dr. A. B. Stout of the Garden has been the prime mover and to which he has contributed the remarkable results of his hybridization work. The choice is a happy one because the species of Hemerocallis are relatively few, and this limitation will obviously simplify the study and enable those participating to do a more thorough job. It has been suggested that if larger genera, such as Campanula or Primula, are to be studied it would be wiser to consider only a subdivision of the group.

The plan begins with a preliminary examination of available literature, and for this purpose Dr. Stout's book *The Daylilies* and Circular 42 of the U. S. Dept. of Agriculture are recommended. The first year's work naturally covers the organization of methods, systems of recording, inspection of nurseries and gardens, selection of stock, planting in the spring and again in the late summer for early-flowering varieties, and intensive culture. The second year is devoted in part to promoting interest in the work, with the aim of inducing more individuals to take up the fun, to the increased opportunities and profit of all. At the end of this period a more scientific study of the plant would be desirable, preferably with the advice of a professional. The third and fourth years' work brings in the comparison of reports, and display of specimens. Here, too, the aesthetic possibilities of the flower might be discussed, in reference to flower arrangement and garden design. In the final year it is suggested that local festivals be held and the conclusions published as a permanent record.

It is to be hoped that the plan will meet with enthusiastic response throughout the country. If even only a few members of each group undertook the experiment, a really valuable body of information should be obtained. Surely no type of garden club work could be more appropriate or more worth while. It is through such programs that the Garden Club of America is becoming a highly important organization in the development of our national horticulture. Full details of the Five-Year Plan are published in the *Bulletin* of the Garden Club of America for March.

BRIEF REVIEWS OF SOME WORTH-WHILE BOOKS

Spring seems to be as important a season to publishers as it is among all those people who admire and cultivate gardens.

Before the first shoots of the snowdrops have penetrated the thawing soil, books of interest to garden-lovers and of consequence to real gardeners begin to appear, tempting workers and students and readers alike.

Of prime importance is the recent publishing of a new edition of the indispensable "Hortus." Among other new books which have already been acquired by the library of The New York Botanical Garden, where they are available for reference, are numerous readable volumes on phases of horticulture, nature study, and related subjects. A few of the new books are given brief reviews in the following paragraphs:

"Hortus"[1]

For the identification of plants under cultivation in North America, coupled with brief but comprehensive directions for culture and for the treatment of essential gardening tasks, every serious gardener knows that no other book is quite so valuable as "Hortus" as a general guide. One point always in its favor is its utter reliability. Now, in accordance with a hope expressed in the introduction to the first edition (1930), "a recognized continuing effort . . . to keep account of the cultivated flora" is being carried out. In these

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[1] Bailey, L. H., and Bailey, Ethel Zoe, Hortus, A Concise Dictionary of Gardening and General Horticulture. 755 pages; 16 plates. The Macmillan Company, New York, new revised edition with supplement, 1935. $5.

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Some of the leading features of The New York Botanical Garden are:

Four hundred acres of beautifully diversified land in the northern part of the City of New York, through which flows the Bronx River. A native hemlock forest is one of the features of the tract.

Plantations of thousands of native and introduced trees, shrubs, and flowering plants.

Gardens, including a new rock garden, a large rose garden, a perennial border, small model gardens, and other types of plantings.

Greenhouses, containing thousands of interesting plants from America and foreign countries.

Flower shows throughout the year—in the spring, summer, and autumn displays of daffodils, tulips, lilacs, irises, peonies, roses, water-lilies, dahlias, and chrysanthemums; in the winter, displays of greenhouse-blooming plants.

A museum, containing exhibits of fossil plants, existing plant families, local plants occurring within one hundred miles of the City of New York, and the economic uses of plants; also historic microscopes.

An herbarium, comprising more than 1,700,000 specimens of American and foreign species.

Exploration in different parts of the United States, the West Indies, Central and South America, for the study and collection of the characteristic flora.

Scientific research in laboratories and in the field into the diversified problems of plant life.

A library of botanical and horticultural literature, comprising nearly 45,000 books and numerous pamphlets.

Public lectures on a great variety of botanical topics, continuing throughout the autumn, winter and spring.

Publications on botanical subjects, partly of technical, scientific, and partly of popular, interest.

The education of school children and the public through the above features and the giving of free information on botanical, horticultural and forestral subjects.

The Garden is dependent upon an annual appropriation by the City of New York, private benefactions, and membership fees. Applications for membership are always welcome. The classes of membership are:

Benefactor	single contribution	$25,000
Patron	single contribution	5,000
Fellow for Life	single contribution	1,000
Member for Life	single contribution	250
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JOURNAL
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NEW DEVELOPMENTS IN DAYLILIES[1]

The daylilies are hardy herbaceous perennials of the Lily Family. They are, so to speak, half-sisters of the true lilies and like them they possess flowers of conspicuous size, color and beauty. Most of you who are gardeners are, I am sure, familiar with the Lemon Daylily, known botanically as *Hemerocallis flava,* and the tawny or fulvous Europa Daylily, known as *Hemerocallis fulva.* These two plants represent the general characters of the group.

All plants in cultivation are either members of wild species that have been brought into culture or they have been derived as the descendants of such plants. Hence the development of any group of garden plants, such as the daylilies, involves, *1st,* the discovery of wild types which are brought into cultivation; *2nd,* the selection of chance variations which may appear and attract attention; and, *3rd,* the deliberate effort to obtain new types by hybridization and selective breeding. When a seedling daylily is obtained it may be multiplied by division to give what is called a clonal variety or a clone—spelled c-l-o-n-e. All members of a clone are merely branches of one original seedling. The clone is a unit of plant life especially important in horticultural practices and the distinction between a clonal variety and a true variety, all members of which are grown from seed, is fundamental. The development of horticultural clones of daylilies, as for many other perennials, consists in obtaining seedlings of merit which are then multiplied by division.

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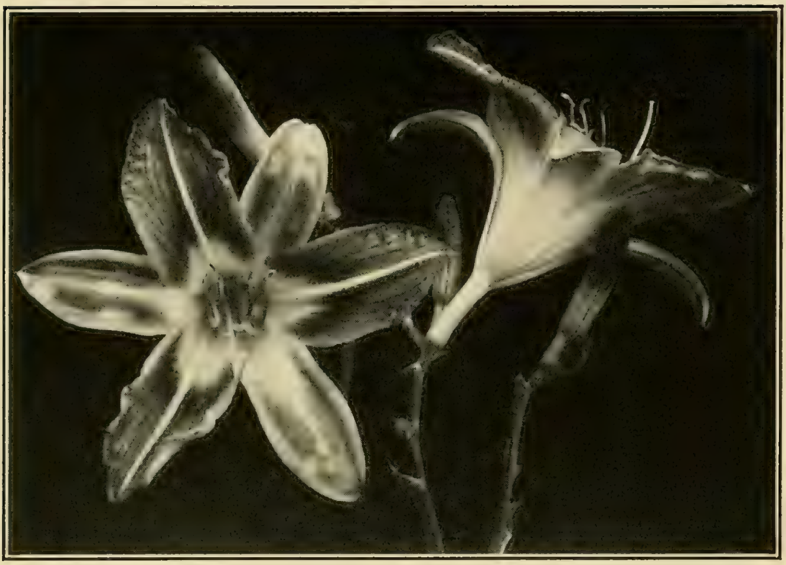
[1] From a radio talk given over Station WOR on July 12, 1935, as a part of The New York Botanical Garden's contribution to the programs of the Radio Garden Club, under the general direction of the Extension Service of the New Jersey State College of Agriculture, Rutgers University.

To understand the development of the cultivated daylilies, it is necessary to recall the introduction of the wild types. The native home of the daylilies is in the temperate regions of Asia—chiefly in Japan, China, and Siberia. It happens that two daylilies had already been taken from the Orient into Europe for culture as medicinal plants and as garden subjects at the time when the first books were written about such plants—about 350 years ago. One of these is the Lemon Daylily; the other is the fulvous Europa Daylily. These two have been propagated continuously by division and hence the many thousands of plants of each of these two types which now exist are branches of a clone that is at least four centuries old. This is a remarkable and unusual record, which attests the vigor, the hardiness, and the immunity to disease which characterize the daylilies as a group and contribute greatly to their value as garden plants.

From time to time other types of daylilies were brought from the Orient to Europe and America until now at least fifteen distinct species are to be recognized. There is in these types a wide diversity in respect to stature of plants, habit of growth, season of flowering, and in the color, the size, and the form of the flowers. In stature there is a range from about a foot in height to seven feet tall. The flowering season extends from May until heavy freezes in October. The colors of the flowers include yellow and orange in clear colors and orange in combination with fulvous red. These wild types provide excellent material for hybridization and selective breeding. It is certain that other wild types remain in the Orient to be discovered, introduced into culture, and used in hybridizations in the further improvement of the group.

It is to be noted that almost no improvement of daylilies has occurred in the Orient. One interesting horticultural type which has double flowers has long been known in both Japan and China. Certain types have been cultivated in China because the flowers are used as food, which is deservedly regarded as a delicacy. But only a few of the hybrid daylilies now grown as garden clones originated in the Orient.

In Europe the production of the horticultural daylilies began



FLOWERS OF THE BAGDAD DAYLILY

FIGURE 1. In the flowers of the Bagdad Daylily shades of orange, fulvous red, and madder-brown combine to give a pattern that is attractive and pleasing.

about 1890. Several species were being grown side by side in gardens and a few accidental hybrids appeared. Then it occurred to the now well-known horticulturist, Mr. George Yeld, who is still living, that the species of daylilies might be good subjects for hybridization and breeding. Most of the hybrids of that early date involve the Lemon Daylily and the two semi-dwarf species *Hemerocallis Dumortierii* and *Hemerocallis Middendorffii.* Some of these hybrids are excellent and will probably never be surpassed for their own respective classes. Of these Estmere, Apricot, Sovereign, Gold Dust, and Tangerine may be mentioned. These clones are semi-dwarf; they bloom in May and early June; the flower colors are yellow or orange. Soon several new species, *Hemerocallis Thunbergii, H. aurantiaca,* and *H. citrina* were introduced and these further stimulated deliberate hybridization.

Seedlings continued to appear either as chance hybrids or as the product of breeding endeavor until in 1925—after a period of about 35 years—about 100 such plants had been named as horticultural clones, and to some extent most of these were propagated by nurserymen and grown in flower gardens. Some of these types, as Luteola, Aureole, and Florham, bloom in late June and July and were welcome additions to the group of garden daylilies.

During the past ten years the interest in daylilies has greatly increased and more attention has been paid to the growing of seedlings. As a result another 100 horticultural clones have been named and at least one thousand seedlings of merit have come into existence from which selections are being made for introduction in the near future.

How shall we evaluate the 200 clones of daylilies that have now been named for garden culture? Many are of no special merit and need not be considered for culture. In the development of any group of garden plants certain seedlings are likely to be named and introduced by persons who know too few types and who have few seedlings from which to make selections. This has been and still is the case for daylilies. Some of the daylilies which would be rated high are very similar to each other. A critical evaluation of all the daylilies now in the nursery trade would probably recognize twenty-five or thirty clones that are both excellent and distinctive. In fact daylilies have become so diverse that this number of clones may be selected without close duplication of type and character. In stature there is a range from semi-dwarf plants that stand about two feet tall to robust types six feet tall. In the extreme habits of growth there are drooping foliage and flower stems and there are stiffly erect foliage and scapes. There are clones that are strictly day-blooming, clones that bloom chiefly at night, and others whose individual flowers last for two days. In respect to the season of flowering a selection can be made which will provide succession of flowers from the middle of May until late in August. In respect to colors there is a wide range in the shades of yellow and orange, both in clear colors and in combination with fulvous red. In some of the clones recently introduced, as in Mikado Daylily, there is a conspicuous blotch of dark mahogany-red in the midsection of each petal. There is also much diversity in the fragrance, form, size, and shape of the flowers.

I am certain that very few of you who are listening to me have seen the 25 or 30 daylilies that represent the range of excellent horticultural types. You may wish to ask how you may become acquainted with them. There is descriptive literature in popular horticultural and botanical publications and there are the catalogs of nurserymen. But it is always a wise procedure to see a living plant of any kind before it is obtained for one's own garden. Daylilies may be seen in various nurseries; the newer and better ones are being grown more widely in private gardens; and special collections are being assembled in public displays in various parts of the United States.

The most complete collection of species, horticultural clones, and seedlings in existence has been assembled at The New York Botanical Garden. Here are representatives of the known species, various wild types thus far unnamed, and all the horticultural clones that it has been possible to obtain. Special effort is made to obtain the new clones as soon as they are offered to the trade either in Europe or in America. Gardeners and nurserymen may visit this public display collection to observe and to compare the various daylilies and to make their own decisions regarding the relative merits of the selections that seem most desirable for culture.

There are also at The New York Botanical Garden about 10,000 seedlings of recent breeding and some 500 seedlings that have been considered as the best among 50,000 seedlings grown during the past 20 years. These are being critically studied and compared and the ones that are judged most excellent and distinctive will be named for propagation by nurserymen. Gardeners and especially those who are interested in daylilies are cordially invited to inspect the collection. These plants include many distinctly new types of horticultural interest which indicate what the daylilies of the immediate future will be. There are always numerous plants in flower at any time from early May until late in autumn.

The Garden Club of America has recently adopted a plan for a five-year study of the daylilies. Collections of the horticultural clones will be assembled in various gardens for critical comparison and evaluation. The results of these studies and tests will no doubt be of value in acquainting the general gardening public with the merits of the daylilies.

Most of the horticultural varieties developed in recent years are the results of several generations of breeding. As new types of wild species were obtained, the possibilities have been expanded; and each clone, finally selected and christened, represents years of experiment.

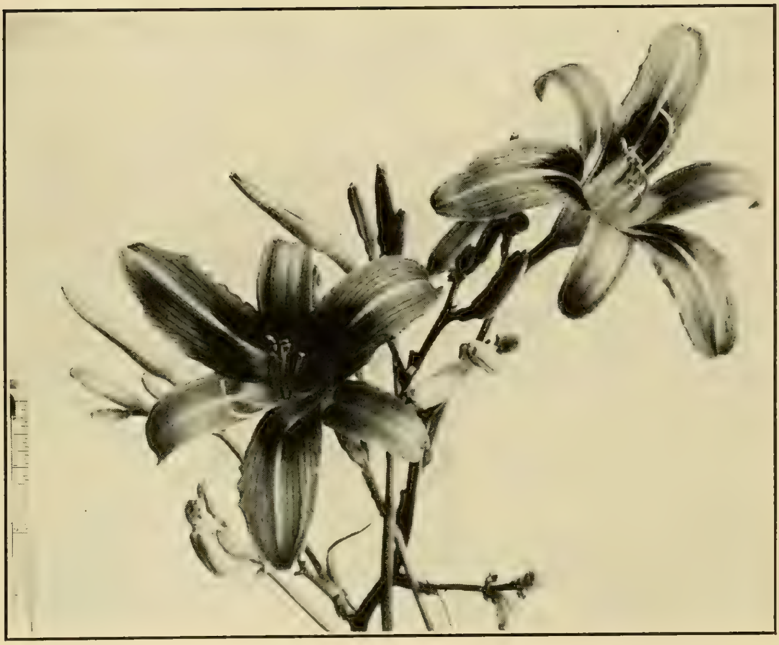
Some report may be of interest concerning the newest developments in the breeding of daylilies and for this a few projects may be reported which illustrate what is being obtained and how the results are accomplished.

There is a dwarf species scarcely a foot tall called *Hemerocallis nana* which grows wild in southwestern China. It would seem that this plant would be a valuable subject for rock gardens but it has not thrived under culture. This species was hybridized with a dwarf clone of the fully hardy *Hemerocallis Dumortierii* and hardy dwarf hybrids have been obtained that promise to be excellent plants for gardens. Further selective breeding is in progress which aims to diversify this dwarf group in respect to color, size, and form of flowers, to increase the number of flowers and to extend the season of blooming.

To cite another case, certain plants obtained a few years ago from the wild in China proved to be a distinctly new type of daylily. The flowers are small, the flower stems much branched, and the season of flowering is in autumn. This species was named *Hemerocallis multiflora.* Plants of this late-flowering daylily were hybridized with nearly all of the other species and several thousand seedlings were obtained which give a wide range in form, size, and color of flowers. In the vicinity of New York this species and its hybrids extend the season of flowering for daylilies throughout August, September, and October.

A few plants obtained from north central China are to be classed in the species *Hemerocallis fulva.* But they differ from the known types of this species in having flowers of bright rosy pink colors. These plants were used in selective breeding and in hybridizations and seedlings were obtained which have sprightly and even brilliant flower colors including shades of attractive rosy pink.

To illustrate the results possible in selective breeding from the old types of daylilies, mention may be made of the origin of the Theron Daylily which has flowers of a dark mahogany-red color that approaches purplish black. This plant has in its ancestry the old familiar fulvous Europa Daylily, the pale fulvous *Hemerocallis aurantiaca,* and certain yellow-flowered types. The first



FLOWERS OF THE RAJAH DAYLILY

FIGURE 2. The color pattern is conspicuously eyed in a garnet-brown with blades of English red, traversed by darker-colored veins, and the throat is greenish orange. The colors differ from those of the Mikado daylily.

two generations of seedlings obtained were as a rule paler than the Europa Daylily. But selections were made for both the intensity and the area of the red pigmentation. After five generations of such selective breeding plants were obtained which have the entire flower area outside of the throat deeply and richly colored with dark red pigments. The most attractive and distinctive of these seedlings was named Theron. Thus a new garden class was developed from the old types.

These four cases are representative of the various projects in the production of new horticultural types of daylilies by hybridization and selective breeding.

The nursery trade has taken an increasing interest in daylilies. Various dealers in the United States are now propagating certain of the older clones and there is considerable stock of some of these. The newer clones are also propagated but for most of these the supply of plants is limited. A rather large number of the very best of the seedlings recently developed—such as the dwarfs, the autumn-flowering types, and those with the dark red and the rosy pink flowers—now exist in single plants or as a few divisions and it will necessarily be several years before they can be made available.

Daylilies have always ranked among the most *dependable* of garden plants. For hardiness, vigor of growth, ease of culture, and freedom from disease they are unsurpassed. A daylily is a sturdy and permanent feature in the garden. Wide and pleasing diversity has now been added to dependability. There are now many classes of horticultural daylilies which are quite as sturdy as the parent species and surpass most of the older types as garden plants of charm. Today the daylilies are to be ranked among the most desirable of herbaceous perennials.

* * * *

In addition to the radio broadcast printed above, a few statements may be made regarding the objectives and the scope of this research with the genus *Hemerocallis*. In the sequence of their conception the main aims may be stated as follows:

(1) *The study of sterilities* and especially of the self- and cross-incompatibilities which operate within species. This involves experimental tests and cytological studies in the laboratory. Several other types of sterility are found in the daylilies and these are also being studied.

(2) *The botanical evaluation of the species.* For this phase of the study, seeds, from which plants are grown, and living plants have been obtained from various localities in the Orient. Much that is new to botanical science has been learned about the genus and two new species have already been described and used in breeding. One of these is the *Hemerocallis multiflora,* mentioned above.

(3) *The hybridization of the various species and selective breeding* in reference to (a) sterilities, (b) relationships and the origin of the species, (c) inheritance of specific characters, and (d) the development of new and improved types of value for garden culture.

Thus the research began and has been continued along somewhat technical botanical lines. But after a few years it became evident that the group of daylilies presented special opportunities for horticultural development and that the principles involved in the synthesis of new forms by hybridization and selective breeding could be determined in the production of desirable types. The possibilties of such breeding are illustrated in the production of a new race with mahogany-red or purplish-tinted flowers of which the Theron Daylily is a selection. In this case, as in others, the records of ancestry, together with the findings of the cytological studies of the nuclear organization, are being used to analyze the hereditary basis for such noteworthy changes in flower color.

The first seedlings of promise for garden culture were obtained about fifteen years ago and reported a few years later.* It was decided then that The New York Botanical Garden could not and should not undertake to propagate these plants either for sale or general distribution. Various nurserymen in the vicinity of New York City, some of whom had favored the Garden with contributions of plants, were approached but not one of them was interested in daylilies or willing to coöperate in any way in testing and propagating the most promising seedlings. Letters were then written to more remote nurserymen. The only response came from Bertrand H. Farr, who had already accumulated a collection of daylilies and had himself obtained hybrids with the *Hemerocallis citrina* as one parent. Mr. Farr came to see the seedlings at The New York Botanical Garden and offered to coöperate in testing and selecting seedlings and to undertake the propagation and the introduction of those which finally survived critical evaluation. After due consideration by the authorities of The New York Botanical Garden this plan of procedure was adopted on the basis of exchanges for plants desired by the Garden. Mr. Farr's death came soon thereafter but the coöperation was continued by Mr. C. M. Boardman and Mr. H. G. Seyler, who had been associated with Mr. Farr and who continued the nursery which he founded. Accordingly the Farr Nursery Company has obtained more than 100 of the first-selection seedlings of *Hemerocallis* and has propagated these for comparison and evaluation. Some have been discarded, even after considerable stock had been propagated, when better seedlings in the same class were developed. No clone is named or distributed except by consent of the writer.

Recently popular interest in daylilies has greatly increased. Many requests now come to The New York Botanical Garden for plants. As far as is possible, divisions have been taken from the plants growing in the display garden to supply educational institutions with collections of species and named varieties and the Farr Nursery Company has in various cases contributed for such purposes plants of the newly named clones. A total of at least 50 nurserymen, some from remote localities in the United States have within the past few years requested plants of the newly named clones and some have asked for the very best of the latest and unnamed selections. Requests for plants have also come from many gardeners, including various members of The New York Botanical Garden. Certain persons have even asked for the most promising stock that has been developed for the breeding of new types, so that they too may undertake the same lines of breeding that are in progress at The New York Botanical Garden. All this is gratifying; but it is physically impossible to supply the plants requested. To undertake the propagations necessary for this would absorb the facilities for growing plants and especially the quota of labor available and greatly decrease the extent of the experimental and botanical research involved.

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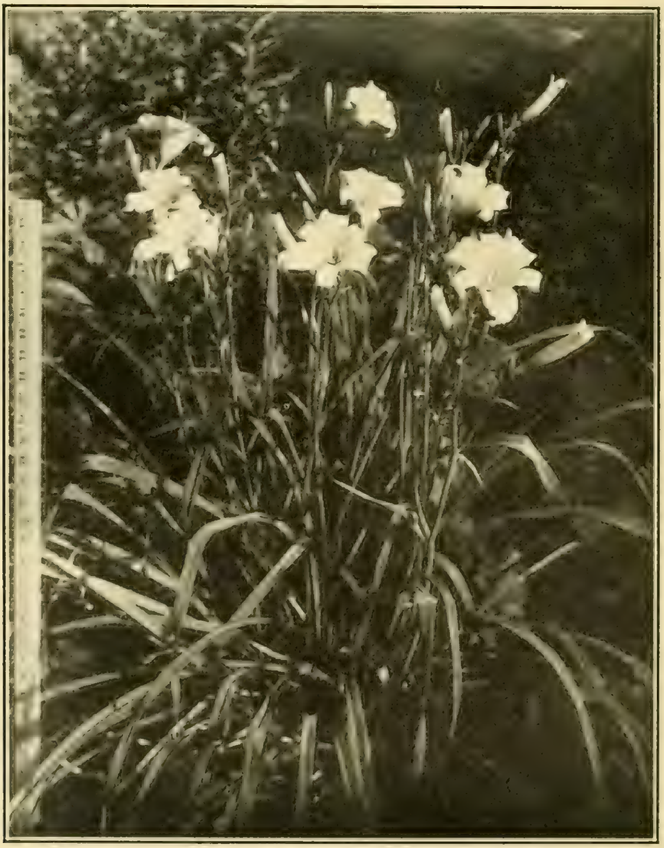
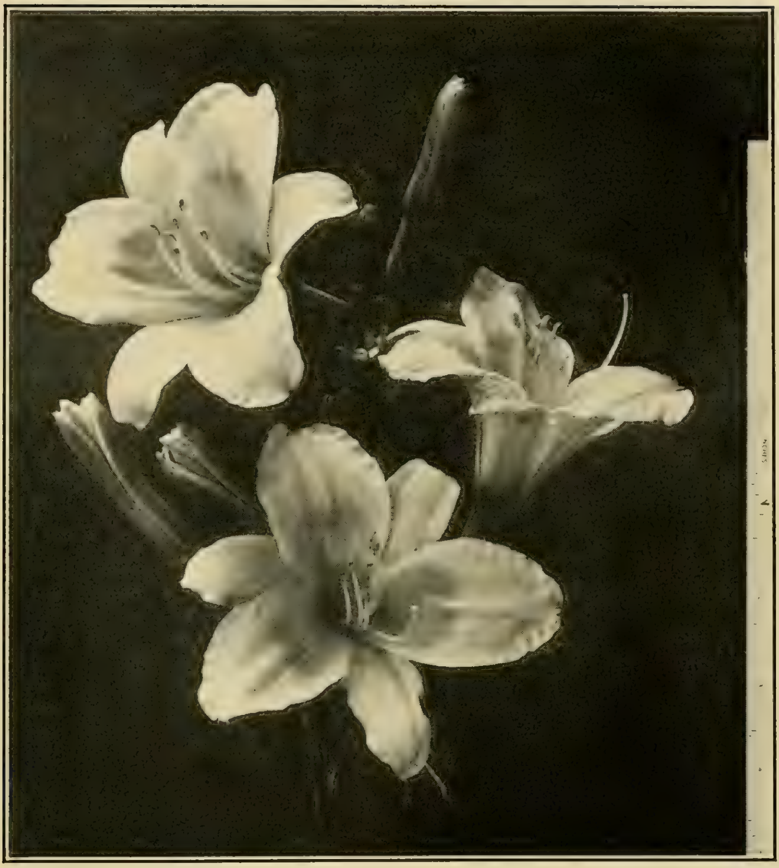
* New Daylilies. Jour. N. Y. Bot. Gard. **26**: 169–178. Aug. 1925.

In the selections of seedlings only the very best individuals in



THE SONNY DAYLILY

FIGURE 3. The habit is excellent. The flowers are medium large, full, pale yellow and firm in texture and they are widely open for about thirty hours. The period of bloom is in late July and early August. An outstanding plant in its class.



FLOWERS OF THE DAUNTLESS DAYLILY

FIGURE 4. The colors are in pastel shades of pale yellow-orange and a midzone of pale fulvous that are subdued and delicately blended in a flower of good form and texture. The plant stands about three feet tall and the period of bloom is in July.

the various classes are kept. The rest are discarded. Recently the general quality of the seedlings has greatly improved and so some of the discarded plants have been used in naturalistic plantings in suitable locations in the Garden. Requests soon came from certain members of the Garden for some of these seedlings for similar use, and so in 1934, ten seedlings were distributed to each member of the Garden who responded to the notices sent out. For the present at least this has utilized the supply of discarded plants and there are no more available.

As a partial recognition of the support given to the Garden and of the interest in its work the following procedure is being considered. An attempt will be made to propagate five of the best of the new seedlings representing several distinct types until there are 25 to 50 plants of each—a matter of three to five years of continuous propagation. Then notice will be sent to all members and at least one plant will be supplied to any member of The New York Botanical Garden as long as the supply will permit. Thus the members of the Garden will obtain plants which, at that time, can be obtained in no other way.

Descriptions or mention of newly named seedlings have appeared from time to time in certain publications of The New York Botanical Garden* and in other botanical and horticultural publications. Some of these clones, such as Soudan, Vesta, Cinnabar, Mikado, and Wau-Bun, are now in many gardens and also in the hands of various nurserymen.

Four of the selections which are to be distributed to the trade this autumn for the first time by the Farr Nursery Company are illustrated in the figures accompanying this article. The names given to these are Rajah, Dauntless, Bagdad, and Sonny. The photographs here reproduced with the brief descriptions indicate the outstanding characters of these new daylilies.

Other daylilies which are to be introduced soon are as follows:

The MIDAS DAYLILY. A robust plant with a clear and rich orange color in the flowers.

The PATRICIA DAYLILY. A plant slightly lower in stature than the Sonny Daylily, and also its flowers are different in shape and in shade of yellow.

The SERENADE DAYLILY. A robust plant with slender bending scapes and flowers of crinkled and wavy petals and delicate and subdued shades of pale yellow and pale fulvous.

The SUMMER MULTIFLORA HYBRIDS. About fifty almost identical sister seedlings are being propagated as a group to provide for the immediate distribution of a new class of small-flowered orange-colored daylily for midsummer flowering.

The CHENGTU DAYLILY. This is a fulvous daylily from China. It is less course, more dainty in habit of growth, and more attractive in its flower colors than any other of the fulvous daylilies thus far obtained from the Orient, with the possible exception of the *H. fulva rosea,* which is quite different in shades of color.

A. B. STOUT,
Director of the Laboratories,
THE NEW YORK BOTANICAL GARDEN.

AUGUST 15, 1935.

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* See especially "Notes on New Hybrid Daylilies," in Jour. N. Y. Bot. Gard. **32**: 25–33. 1931. "The Bijou Daylily," Jour. N. Y. Bot. Gard. **33**: 1–4. 1932. "The Soudan Daylily," Jour. N. Y. Bot. Gard. **33**: 104–105. 1932.

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